COLLEGE OF ENGINEERING CORNELL UNIVERSITY

the Cornell engineer

JANUARY, 1953

VOL. 18, NO. 4

25 CENTS

How two inches of steel made a yardstick

HERE is one of the busiest machines in our research laboratories. It is a *constant-pressure* test lathe that quickly provides an indication of how fast a steel can be machined.

This unique testing device consists of a standard lathe fitted with special control equipment by which the horizontal pressure on the cutting tool is kept constant during the machining operation. By actually machining a test bar on this lathe and measuring the number of revolutions necessary to advance the cutting tool exactly two inches, we obtain—in a matter of minutes—a precise record of the steel's machinability.

Before this development, the normal way to test machinability was to machine a sample of steel until the cutting tool failed. This sometimes took days and often required more steel than was available. Now, with the constant-pressure lathe, many steel compositions can be *accurately* checked in that time.

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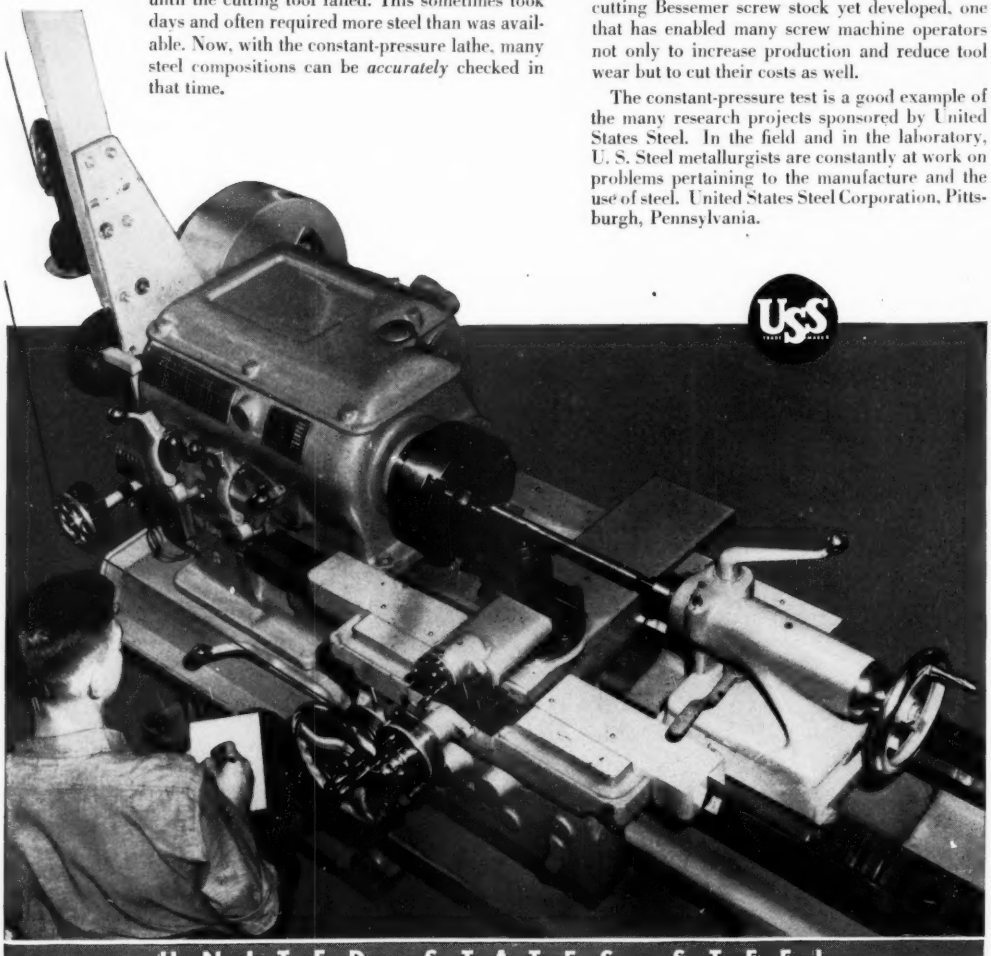
The constant-pressure test is a good example of the many research projects sponsored by United States Steel. In the field and in the laboratory, U. S. Steel metallurgists are constantly at work on problems pertaining to the manufacture and the use of steel. United States Steel Corporation, Pittsburgh, Pennsylvania.



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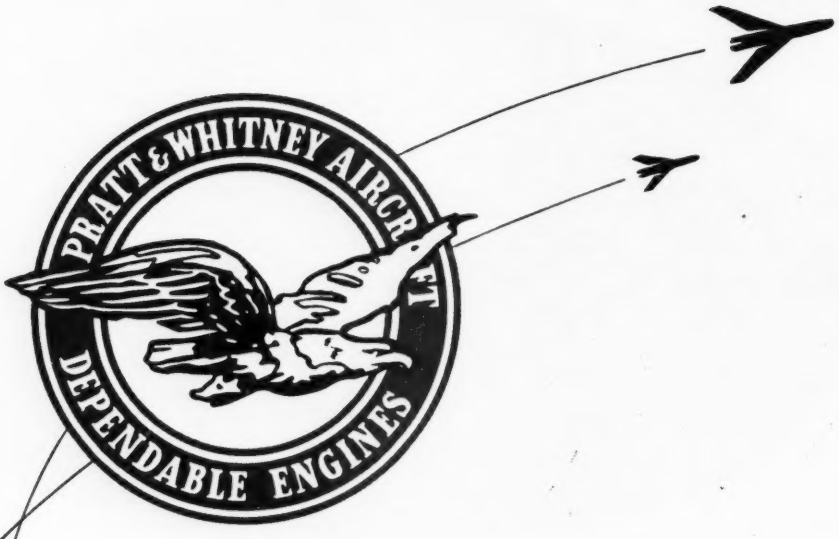

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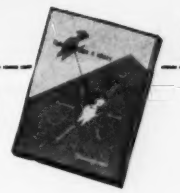

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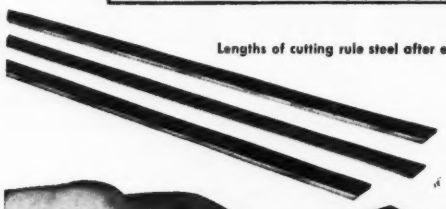
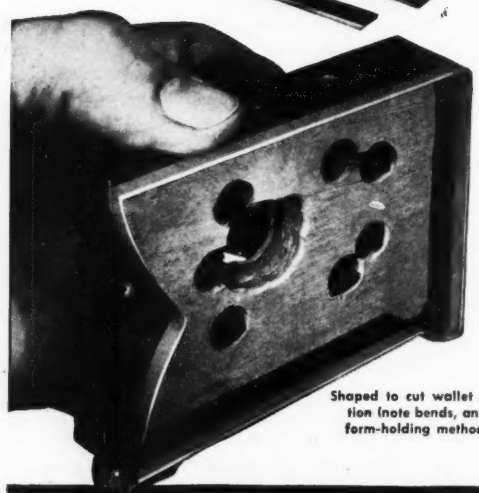
What's Happening at CRUCIBLE

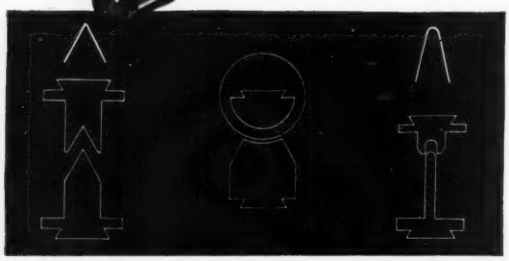
about scoring and cutting rule steel



Lengths of cutting rule steel after edging



Shaped to cut wallet section (note bends, and form-holding method)



Some examples of the many shapes of bends needed

Scoring and cutting rule steel is a cold-rolled specialty steel for use in preparing dies for cutting paper, leather, rubber and other materials.

It is a pre-tempered product manufactured by skilled workmen, using precision rolling and hardening equipment, to close limits for chemistry, grain size and hardness. This product must also be capable of meeting intricate bend requirements in the hardened and tempered condition.

This specialty is furnished with round edges and in coil form to the rule manufacturer who grinds the edges — the one edge square and the other to a knife edge as well as cutting the material into desired lengths. This is sold to a die-maker who bends the rule to the required shape. This is then the nucleus of a pre-hardened die, which when properly brazed and supported is used to cut out material for display cards — aircraft parts — pocketbooks — wallets — gloves — gaskets — washers.

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Let's keep the record straight

There has been too much loose talk about prices, wages, dividends, taxes. Let's see.

Compare 1939 (the last normal year before the war) to 1951 (the last year for which there are figures).

Prices have gone	**up**	**86%**
Weekly earnings of production workers	**up**	**172%**
Dividends of corporations	**up**	**148%**
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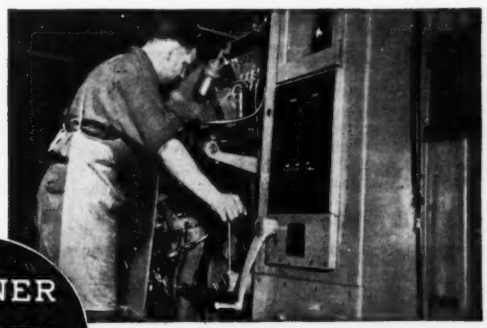
Remember the figures. Just for the record.



WARNER & SWASEY
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Machine Tools
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Sources: Tax Foundation; U. S. Department of Labor; Annual Report of the Secretary of the Treasury and The Budget for the Fiscal Year, 1953.

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WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

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COVER—Familiar to Cornellians is snow-covered Sage Chapel.

Robert Stuckelman

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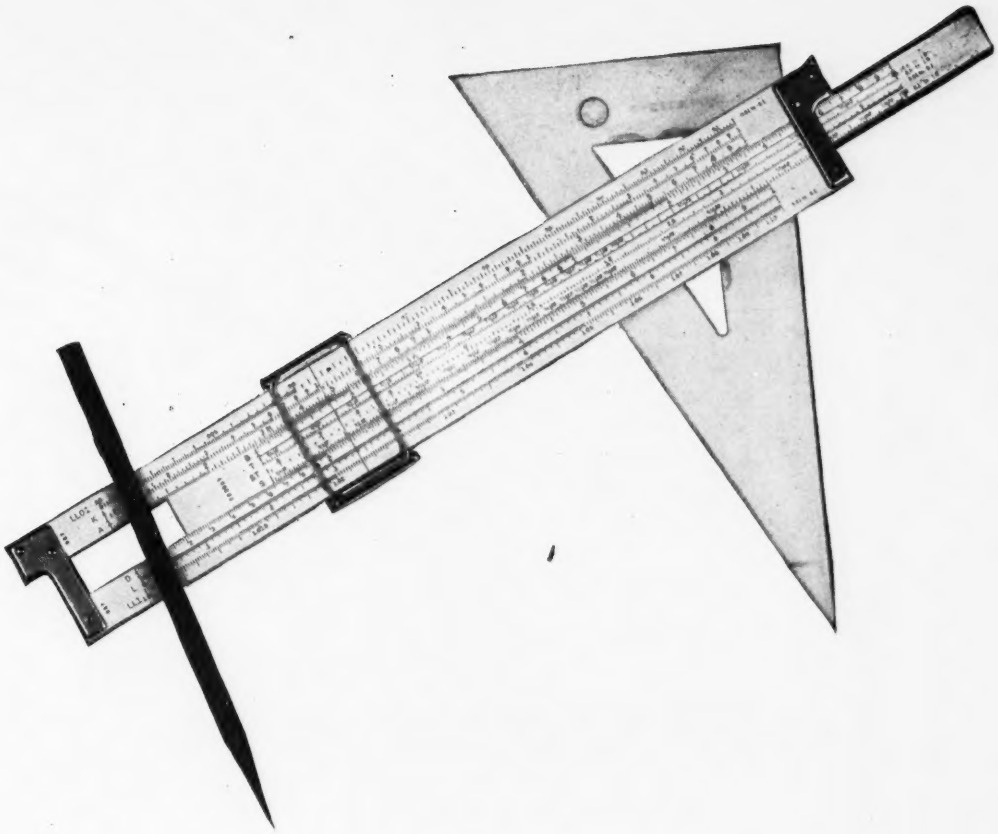

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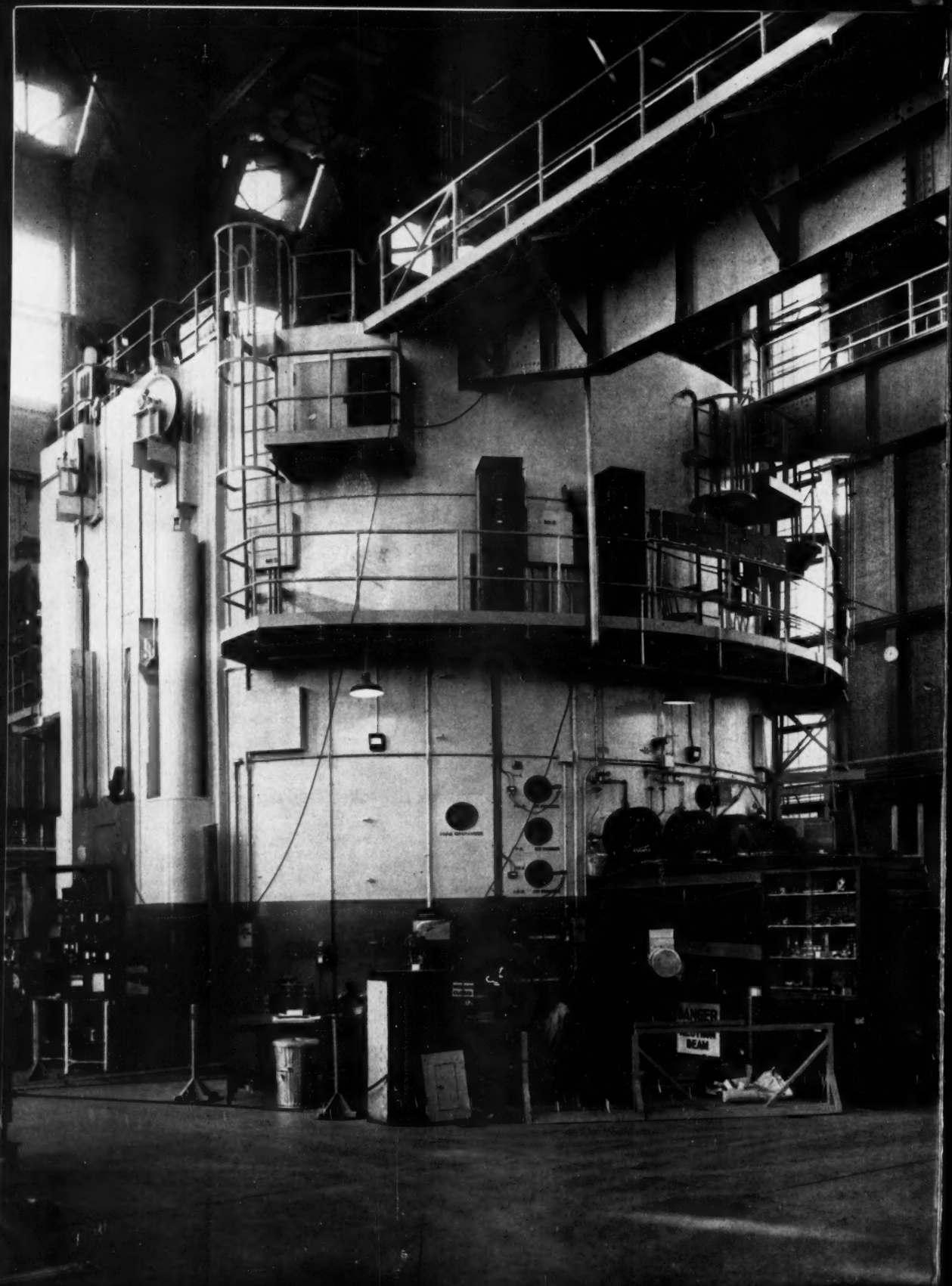
DANGER
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Work Simplification

By ALLAN H. MOGENSEN, M.E. '24

Work simplification is one of the best possible means of getting participation in the shop and office. It may also be one of the best means of achieving increased productivity. There is no need to discuss the need for increased productivity. Nearly everyone seems to feel that we are limited in our use of equipment, our facilities and our manpower; that if we get increased productivity, we will have to give up something else. In disagreement with this view, let us talk about the possibility of increasing productivity to the extent that we can maintain our arsenal economy and still live well. The only question to ask is: how can we pay for all this? Will we be able to pay for the continually increasing cost of government and the arsenal program? Not unless we become much more efficient than we are now. Waste of manpower and equipment must stop. American industry has done very little in training executives in the past 20 years in economy, in real competition, in getting costs down, in increasing productivity. We talk about production, but we do not distinguish between production and productivity.

Why is this job undone? Why is it so difficult? It may seem that it is being done—we have methods departments, industrial engineering departments, cost reduction departments. But the results are the real test—and these come through the organization's employees. This job of increasing productivity is to be done through people, and there are three ways to get results through them. All the advantages and usefulness of the plant and equipment and floor space do not eliminate the workers.

The Chalk River N.R.X. Nuclear Reactor in operation.

Three Techniques

The first way is to "tell them." We have used this technique for a long time. At a conference, the men sit around the table and at the back of the room and one or two of them say to each other, "I don't know what the hell we are in here for. The old man is just going to 'tell us what he is going to do.' He made up his mind before he came in here." One of the most difficult things to run is a real conference. We like to tell people and to be in a position of authority.

The second way is to "sell them." We are making some progress in that direction. Today if we start an intelligent time study program we do some selling. Incentive plans? Get some smart fellows up in a meeting of industrial engineers, or management men, and they will make monkeys out of us by picking one of these long complicated formulas for incentive pay. They ridicule us by asking "how could any worker ever figure that thing out?" In our attempts to be more accurate and more scientific we have failed to tell people what it was all about, and we have failed to bring it down to language they can understand. Now we are trying to do a better job.

In the scientific management field we have entered the era of selling people on new ideas, new methods and new improvements. We are doing it now when we put in a new system of job evaluation, or a new system of production control, whatever it may be. We spend money on films and dramatization, and are gradually waking up to the fact that we can not say, "This is it. You are going to take it whether you like it or not."

The third way of getting results, and most effective, is to "consult them". We are beginning to see a few attempts in the army to try this third technique. The Air Corps used it in the last war. When the boys came in from a mission no matter how tired they were, no matter how beat up they were, they were brought in for questioning. What happened? What can we learn from this mission? What can we do next time so we don't make the same mistake? The top brass consulted the boys. That was something new.

But it is not well sold I can assure you. The *New York Times* discovered that when someone was no good and no one knew what to do with him, he was made an Information and Education officer. Too often the one who was Information and Education officer said, "I stick them in a room and turn the film on and then I go out and get a smoke until it is over." One general said, "It's all a lot of hooey. All the soldier needs to know is where he is to be and when he is to be there. Don't tell him anything else." There are a great many who still believe that the only way to run an army is to "tell them."

In scientific management, or industrial engineering, we are progressing through the "sell them" stage; some of us are now embarking on that third and most effective

stage, the consultative approach. As a result of our early mistakes, today we have feather-bedding, resistance, make-work restrictions, and all the rest. We must convince people that what we want them to do is to work *smarter*, not *harder*.

No one says that one, and only one technique is the thing to use. The boss has certain information to give and he calls the group in, "here is the information." That is the "tell them" conference and it should be. Very often questions and discussion are admitted, but usually this is straight informational, straight "tell them."

Most Effective Approach

But the third approach is usually the most effective. It may not always work alone, and sometimes selling is necessary. But there is sometimes the instance where everything has been tried to consult someone, the best has been done to sell him, and as a last resort one goes to him and says, "Joe, I'm sorry but if you don't want to go along, you are not going to be working here, because this is the way we are going to do it." In other words there are certain things in the managerial function which are the managerial function and which should not be arbitrated or bargained over.

The user of the consultative approach should be humble; that is usually something unpleasant. If he holds a real problem-solving conference with executives, supervisors, or rank and file, he must say seriously and honestly, "Well boys, how can we solve this problem?" If he thinks, "I read somewhere in a book that this is the way to get cooperation, so I will go along and kid them," he will kid no one. Humility is hard. One must frankly admit that in such a group may exist better ideas than one's own.

Young executives have said, "If I did that, wouldn't I lose the respect of these men? Wouldn't they say, 'How did he get his job if he doesn't know all the answers'?" It is nice to think one knows all the answers, but occasionally one gets out on a limb. The boys in the back may know just what is wrong and why it won't work, but they go right on sitting and listening. One of them may say, "Why don't we tell him he is wrong?" Another will retort, "Do you think I am going to get my head chopped off? Let him hang himself . . . he'll find out." Make your positive statements. Walk out and say "I told 'em." This is not the way to win the respect of the group.

An Inevitable Trend

The new method is a very noticeable trend, an inevitable movement, and whether we like it or not, a showdown in the world between two ideologies. First is represented a "tell them" technique. But we are trying to prove that the democratic approach, the consultative approach, can be more successful. "Yes, but to get quick action, you have to tell them." You get quick action that way—sometimes. Naturally the consultative approach takes longer.

Most of us have done methods work, cost reduction, or whatever we call it, by the exploiting, "tell them" approach. We hire industrial engineers who make plant layouts, and work with three-dimensional models. They give the layout to the engineers, the engineers blueprint it, and there it is. The worker is told, "That's your location. That's your machine." This is the quick way—and he feels it.

The slower way is to bring the boys in for a consultative meeting where everyone participates in working out the problems. The danger right now is that under the pressure of this arsenal economy too many say that there is no time for it. We take the easier, quicker way. That is something to decide. Be convinced that it will pay in the long run to use the consultative approach.

This approach has worked in many instances on specific operations where improvements were wanted. In union plants where there were feather-bedding rules against improvements the union absolutely refused to put in the new method or the new layout or the new machine. Then the identical changes were made in another plant with the same union, same feather-bedding rules, and the boys told how good it was. "This is our idea." This program is working

ABOUT THE AUTHOR

Allan H. Mogensen

Allan H. Mogensen graduated from Cornell in 1924, and went to the University of Rochester, where he taught industrial engineering subjects. During his six years there, he did consulting work for several Rochester firms, and became interested in the motion picture camera as a means of improving methods.

In 1930 he joined the staff of Factory and Industrial Management, **where he wrote articles on motion economy and Work Simplification.**

Very shortly the demand for help in this field induced him to develop his course in Work Simplification, leaving the staff of Factory **except in the capacity of Consulting Editor, a post he still holds.**

During World War II Mr. Mogensen was appointed an Expert Consultant to the Secretary of War, and his Work Simplification program was carried by Mr. Mogensen and others to several important industries, such as the aircraft industry. His articles have appeared in many publications, both here and abroad, and his motion-picture library is in use by most of the universities where his methods are taught. Lately Mr. Mogensen has devoted considerable time to conducting special conferences in Work Simplification for top executives of some of America's outstanding firms.

and has worked with almost every union that can be named. We have had no real difficulty with any union. By difficulty is meant organized opposition to the program or refusal to go along with the program. We have had our troubles. Right now our first program on a railroad is getting 100% cooperation at the bottom. Our trouble is with the top. All of the trouble in these programs is at the top.

In the consultative approach the reasons for difficulty must be questioned. In "The Law of Intelligent Action," William Reilly names three things we must have to get intelligent action on any problem. *First: the desire to solve that problem.* To get people enthusiastically behind such a program as this, first find out what will make them want to do it. Financial incentives? Possibly, although those are stressed far too much. Many of us have concluded that people work for only money.

An example of this is—the man who likes to be assistant to the president. He knows very well he will never be president. He hasn't the capabilities or the possibilities to be president. He has no intention of ever being president. He likes the nice life, the thick rugs, the good looking girls around the office, and the chance to go in the private plane with the boss when he flies places. That is the life he likes and wants.

The common denominators that most people respond to are praise and recognition. Much can be accomplished through praise and recognition. A whole film program of taking "before" and "after" movies consists of films of even small improvements. They are shown to the workers, next to the supervisory group, and later on to the top executive group.

Once people really participate in such a program, there is a change in morale, a change in attitude, a spirit of real cooperation that is hard to believe could be secured in such a comparatively easy way. Many of the executives talk not about the thousands of dollars they save through Work Simplification, but about the change in attitude which eases negotiations when their time comes.

Example of Work Simplification

For example, things are sometimes much simpler than we like to make them. Standard Register Co. in Dayton, has had a program for many years. After the war they were backlogged in their big printing department. Running full capacity they could get no more presses and were falling further and further behind. They decided that the latest graduate of our conference should start right in the press room with the workers. They had had Work Simplification through all management groups — top, supervisory, and middle. He got the boys into the act; that is all this program is. The job in the press room took nine months of hard work with the workers themselves, but at the end, the output in that press room had increased by 30 per cent. The figures on press capacity had convinced management at the start that there could be no increase. Yet they got an increase in output of 30 per cent.

Things were fine for a while but then output dropped to its original low level. "Well, there you are, just one of those things, just a flash in the pan." But the plant manager said, "No, let's find out why." The Work Simplification man had been moved into the department ahead where they made the plates for printing. These workers in their consultative problem-solving meetings came to the conclusion that every rubber plate they made was perfect. But these perfect plates were piled up on the floor inside the door of the pressroom and were hit with electric trucks and knocked over. Those who made the plates were being blamed for bad work. To solve their problem, they decided to put racks in the rubber plate department, and they stored the plates in these racks and delivered them to the pressroom when the jobs were ready. In that way their perfect plates were no longer damaged.

But they forgot to tell the pressmen about it. The pressmen saw the work load slowing down and came to the natural conclusion that work was running out. They did what everybody else would do — they started to slow down. But when the pressmen were shown the plates in the racks in the other room, production went up the same 30 per cent and has been there for two and a half years.

Second Requirement for Action

Reilly says the second thing we must have to get intelligent action on any problem is the ability to solve the problem.

Company presidents say, "If I could only hire some good young executives. We are weak there. You can't get good men today." The plant manager says, "If I could only get me a good superintendent. We had one once, he was wonderful. We didn't have any problems then. Now all we have is trouble." The superintendent says, "You

Some executives believe only in the "tell-them approach" to management.

Many workers think of the suggestion-box system in the plant as something like this.

know the kind of foremen you get nowadays. They aren't like the foremen we had years ago. They are hopeless but there is nothing you can do about it." And the foreman says, "These clucks they hire in the employment office! I ask for men and what do I get? They are really scraping the bottom of the barrel when they bring them in here now." The worker says it's the president who isn't any good. We go around in circles.

No one of us seems to have confidence in the men below him. The consultative approach depends on believing that this group of men does have ideas, worthwhile ideas. Ability can be improved through training, of course. But even offering an incentive does not get ideas. Suggestion boxes are proof of that. Before the war 95% of the suggestion plans that were tried, failed. There are many reasons why the ordinary suggestion system fails. The committee idea is not workable. Inviting suggestions by giving awards is putting the cart before the horse.

Train Worker in Techniques

What we must do is give people training in the tools of management. The man makes a process chart, studies his job, works it all out and finds that he has ideas that look good to him. Either by himself or working with his foreman, or with help from the Work Simplification department, he gets to the bottom and finds that it will cost $4,000 to make the changes and that it will save $50 a year. He says, "That is no good. I wouldn't spend my own money on that," and tears it up, mad at nobody. He turned it down himself because it was not a good investment. But if he drops it in a box with all the mystery of a numbered blank and the committee announces a month or two later that the idea is no good and it has been turned down he thinks, "I've been robbed; my foreman stole a good idea; he doesn't like me; somebody else doesn't like it." And so on.

Group consultation, this problem solving conference technique, is being used more and more. Bring in employees, operators on the machine, foremen, supervisors, technical people, any of them—to solve specific problems. How can that be done? Must the plant be shut down? Do we take people off the job? We do it in many places and get amazing results. There are two channels of instruction—one where a person is trained in Work Simplification, learns the tools of Work Simplification, and works out the ideas himself; and secondly we have the solutions worked out by group participation.

Third Requirement for Action

Third, says Reilly, and most important: to get intelligent action on any problem there must be the capacity for handling the human relations problems involved.

Group consultation has no value unless people are able to handle the human relations problems that are involved—in cost reduction, methods improvement, or other techniques through which we are hop-

But the best way to attack production problems is to use the consultative approach.

ing to increase productivity. Interestingly, most of our problems end as human relations problems. Nearly all problems have a technical side and a human phase. Research people, engineers, skilled scientists, can solve any technical problem. But not much progress is made in human relations. This serious problem explains the failure of most attempts at increasing productivity.

Let's look at the causes. First, everyone resists change and new ideas. It is difficult at first to realize that Work Simplification means we work smarter instead of harder. It does not mean speed-up, or work harder or faster. It does mean finding the easiest and best way to do a job; and that is usually done by eliminating the unnecessary parts of the job. "Why" every part of the job. Eliminate the unnecessary parts. Do just what is left and there is plenty of time to do it. This means a different way of doing a job, changed habits, changed layout, work place, tools, equipment, whatever it may be. There will be resistance.

Secondly, we resent criticism. Too frequently we admit these things are true but we do nothing about them. How may we get around this resentment of criticism? One answer is not to criticize. Get the worker to come in himself with a process chart and say, "This is the way we are doing in our department now and I have a plan here where we can change this, and this, and we can do it this way with a saving of so many thousand feet." He is not criticizing himself, or does not think he is. But if someone else as an expert did the same thing, he would take it as criticism. Every time a method is criticized, someone takes it as personal criticism.

How may we get around these two hurdles? The only way is to have people themselves come up with ideas for better and improved methods. This is the method of consultative approach in solving our problems—time—cost—quality.

The important matter in a Work Simplification program, as against what most people call one, is this philosophy of consultative approach. Too many people begin with the experting technique. They will have Work Simplification, and their methods engineers will do it. One of the hardest things to do in Work Simplification training is to hold back some ideas and train people to think for themselves. It has been said there is no expedient to which man will not resort to avoid the hard labor of thinking. We are looking for too many easy answers.

When people talk and think and ask questions, they can do a lot of good if handled properly. There are no short-cuts. This approach must be established high in the management organization, and must receive absolute top-management backing and support, because that is the first essential in success. Then it can be carried down through the organization, allowing enough time to do it right. With real participation, to see the ability that exists among people will be amazing. The brain power, the ability to think and solve problems are in every organization.

Letter To The Editor

To the Editor:

Re: November Brain Teaser

To start with the general: Green could not be the general since he had a superior. Neither White nor Jones could be general because their brothers-in-law were not those of the general. And finally, Brown could not be the general because he did not serve in Italy. So it would appear that Smith was general. That leaves 4x3x2x1 arrangements possible to fill the lower ranks.

Since Brown was not the brother-in-law of the general (Italy) nor of White (Germany), he must be related to Green and Jones. Both Jones and White are not related to relatives of the general, so they must be related to general Smith himself. That gives us the following information.

Rank	Man	Brothers-in-Law
General	Smith	Jones, White
?	Jones	Smith, Brown
?	White	Smith, ?
?	Brown	Green, Jones
?	Green	Brown, ?

To complete these relationships, White and Green must be related to each other. Completing the ranks to suit this arrangement, there are the twenty-four possibilities left.

Since General Smith is not a brother-in-law of the colonel (Japan), only Brown or Green could be colonel. Similarly, only they could be captain (Italy). This reduces to four the number of possible answers. They are:

	1Smith	2Smith	3Smith	4Smith
general	Smith	Smith	Smith	Smith
colonel	Brown	Brown	Brown	Brown
major	Jones	White	Jones	White
captain	Green	Green	Brown	Brown
lieutenant	White	Jones	White	Jones

But White can't be the lieutenant (Germany), eliminating (1) and (3). Number 2 goes because Brown can't be colonel, since this doesn't make provision for White to serve in Japan, while with Green as colonel, his brother-in-law White could have served in Japan.

Now, since one of White's brothers-in-law served in Japan and General Smith didn't, Green must be White's wife's brother. Therefore, filling in the other wives' names:

Rank	Name	Brothers-in-Law	Wife's Maiden Name
General	Smith	Jones, White	White
Colonel	Green	Brown, White	Brown
Major	White	Smith, Green	Green
Captain	Brown	Jones, Green	Jones
Lieutenant	Jones	Smith, Brown	Smith

Yours truly,

Bob Morrison, EP '57
Ithaca, N. Y.

Aircraft Approach Lighting

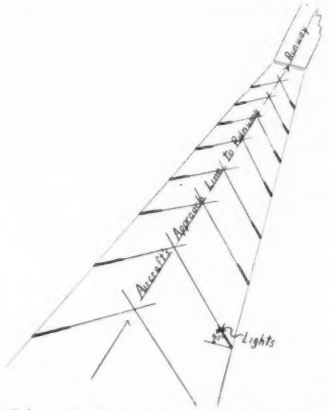
By IAN E. MARWICK, EE '53

Recent developments in electronic landing aids, for both civil and military aircraft, tend to overshadow the need for improvements in visual landing aids. The latest developments in Instrument Landing System (ILS) and Ground Controlled Approach (GCA) enable a plane to land safely with no visual contact with the ground. However, visual contact with the ground is still needed for safe, controlled landings. Tests have shown that the threshold of anxiety of the pilot is exceeded, and in spite of his confidence in the landing system, he feels that the plane is flying into the ground. To correct this feeling, he instinctively wants to pull up before landing. Civil aircraft, with their large numbers of passengers, require every safety precaution in landing, while military aircraft can afford to be less cautious in their methods. Consequently, ILS and GCA cannot be used as the only method of controlling approaches and landings because of the possibility of failure, and the high cost of the airborne and ground equipment. As a supplement to these landing systems, visual approach lights must be used to guide the aircraft to the runway during adverse weather conditions.

At present, there are six proposed systems in use at airports throughout the country. A brief description of each, with advantages, follows.

Funnel Approach

This system of approach lights is so arranged that the lights extend outward and upward from the end of the runway. The first lights are at the end of the runway at ground level. The remaining lights are elevated and form a funnel-shaped structure at about a one in twenty slope, the recommended approach angle for most aircraft. This means that the lights at the end of the runway are on very low mounts; while the outer lights, at a distance of about 1,500 feet from the end of the runway, are approximately 75 feet above runway level. This configuration has a wide, easily found area at the mouth of the funnel enabling the pilot to locate and center himself in the approach zone with little difficulty. The cost of this type of installation is high because of the tall towers needed in the outer portions of the funnel.



Schematic diagram of the slope-line system of approach lighting. Intersections of light center-lines form glide path.

Double Parallel Rows

This method of approach lighting consists of two rows of lights extending parallel to the sides of the runway. Spaced at approximately 100-foot intervals, the lights extend outward a distance of approximately 3,000 feet. The individual lights are all at the same height, about three to five feet above runway elevation. This system gives the pilot a perspective view of the runway and its lighted extension, which appear in one plane. He centers himself in the approach zone and touches down at the end of the runway. The touch-down area is designated by a line of high-intensity green lights extending along each side of the runway for a distance of 200 feet. The disadvantages of this system are the symmetry, making it difficult to distinguish the correct direction in which to approach, and its narrow entrance area, making it difficult to find during times of low visibility.

Multiple Parallel Rows

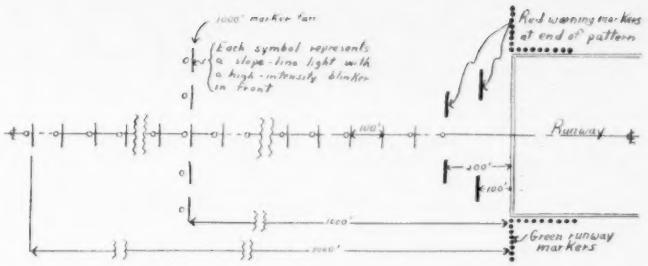
This configuration of approach lights is very similar to the previous one, except that instead of only two rows parallel to the sides of the runway, up to eight rows of lights are used. The additional lights are placed between the two outer rows previously described. This plan results in a large, solidly lighted area that extends from the runway. This lighted area, with its high intensity, is easily located under adverse weather conditions. The touch-down area at the end of the runway is marked in the same way as in the two-row system. The two main disadvantages of the multiple row plan are: (1) the high cost of installation for the large number of lights needed to give a solidly lighted area of approximately 2,500 feet in length, (2) the location of lights in line with the runway prohibits having a 1,000-foot clear-area at the end of the runway. This clear-area is provided in case pilots overshoot or undershoot the runway. On all Air Force fields a clear-area of 1,000 feet is required; therefore, the multiple-row system is not applicable to Air Force installations.

Flashing Parallel Rows

The plan for this approach system is similar to that which was previously explained. Two rows of lights are spaced at 100 foot inter-

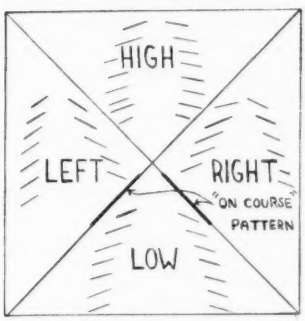
vals, parallel to the edge of the runway and extending out a distance of 2,500 to 3,000 feet. The feature that distinguishes this system is the type of light used. The lights are capacitor-discharge high-intensity approach lights, and are explained in detail later in the report. The lights flash (in succession) for approximately three-hundredths of a second every 1.5 seconds. This successive flashing produces a theater-marquee effect of lightning flashes pointing toward the runway. The high intensity lights are easily seen under adverse weather conditions.

The slope-line system was announced in the latter part of 1948, and since then has undergone considerable discussion. The principle of this system is simple, yet it provides a method for the pilot to maintain not only his proper course but also his proper altitude during the approach. The lights for the slope-line system are 250-watt 90,000 candle-power sealed-beam lamps similar to automobile headlamps. Ten of these units are mounted in a box ten feet long, and are oriented to shine upward and outward toward the approaching aircraft. The boxes are spaced 100 feet apart and make an angle of forty-five degrees with the ground. The lights are so arranged that the intersection of their center lines forms a glide path for the approaching aircraft, as shown in Fig. 1. The center lines of the lights form a figure similar to the rafters of a building, their intersections constituting the glide path. If the aircratf is on the glide path, the pilot sees two continuous converging lines of lights. If he is off the glide path, the continuity of the lights is broken, forming a pattern that clearly indicates the direction of his error.



Plan view of the center-line system of approach lighting.

What the pilot sees for various off-course positions with the slope-line system.



Illustrations of what the pilot sees for various off-course positions are shown in Fig. 2. If the aircraft is too high, the bars of light appear to leave the on-course pattern by having their inner ends bent down, thereby indicating that the pilot should fly down to correct his course. If the aircraft is too far to the left, the right-hand row of lights forms a pattern more similar to a straight line than the left-hand row. The left-hand row is broken by having the inner ends pointing toward the right, indicating that the pilot should fly right to correct his course. In similar fashion, distinct patterns appear for courses that are too low or too far to the right, with the bars showing the direction of the correct approach path.

Despite the apparent merits of the slope line system, the Airline Pilots Association (ALPA) has strenuously opposed its approval by the CAA. The airline pilots, who are the principal users of approach lighting systems, object to the system for the following two reasons: (1) They claim that the off-course patterns, distinct and unambiguous as they seem, are not easily distinguished in the small amount of time available to correct the flight of the aircraft during its approach. (2) They are opposed to any system of lights that verges toward the end of the runway. When a pilot sees a runway from aloft, its sides converge at the far end due to parallax. The slope lines of the lights have to converge at a wider angle than the natural angle of convergence caused by parallax. Because of this difference in angles, the appearance of the combined runway and approach lights is that of a straight line, but with the far end tipped upward. This illusion gives the impression of trying to land on an uphill runway, causing the pilots to level their approach and thus overshoot the runway. Moving pictures of actual approach scenes have been made by the CAA and Sperry Corporation, and bear out the pilot's arguments against this system.

Center Line System

This is the approach system having the approval of the ALPA and CAA. The Air Force has not approved it because there is no 1,000-foot clear-zone at the end of the runway. The center-line system consists of a straight line of horizontal lights in line with the center line of the runway, with cross bars for distance markers at 200 and 1000 feet from the end of the runway. A plan of the center-line system is shown in Fig. 3.

The lights in the center line system are the same as those used in the slope-line system, plus a high-intensity capacitor-discharge lamp in front of each box. The end of the runway is marked with green lights, and at a distance of 200 feet from the end of the runway a red cross bar is placed. A white cross bar serving as a distance marker is situated 1000 feet from the end of the runway. The ALPA approves of this system because it causes none of the optical illusions found in the slope line system. The pilot can easily align himself with the center line without having to read several

direction-indicating patterns or without trying to keep centered between two parallel lines.

In these approach systems, several types of lights are used. The only important difference between various types is the intensity level. The ability of a light to penetrate poor visibility conditions is only a matter of intensity, following the inverse square law. As an example, a 100,000 candle power light at 300 feet, with no fog, has the effect of 1.11 candle power, but in fog which transmits 10 per cent per hundred feet the effect is that of .0111 candle power; therefore, high intensity lights are a necessity.

Lights Used

The lighting of most approach systems consists of a series of neon tubes arranged about a capacitor-discharge blinker lamp. The neon tubes are used for low-intensity lighting up to 100,000 candle power. For high-intensity lighting the blinkers are used to supplement the neon lights. The blinker lights are capacitor-discharge operated and have a small krypton-filled tube about four inches long and one-half inch in diameter as a source. The flash lasts for about three-hundredths of a second and is repeated every 1.5 seconds; it has intensity of 3.3 billion candle power.

The other approach light in present use is the slope line light already mentioned. It consists of ten 250-watt sealed-beam units of 90,000 candle power, mounted in a box ten feet long and about one foot square. This arrangement, when viewed from aloft, gives the effect of a single light source about ten feet in length and enables the pilot to align the slope line bars when using the slope line system.

There is still considerable controversy among ALPA pilots, the military, and CAA, as to which approach lighting system, if any, should be adopted universally. At present, all systems are in use, or under trial; recent developments seem to point to the adoption of the center-line system, which has the enthusiastic support of the ALPA and probable CAA approval, but as yet, no support from the military.

Behind The Iron Curtain

Work is nearing completion in Poland on extensive plans for river reconstruction which in the next few years will considerably alter the geography of the country. The project envisages flood prevention for an area of more than 1,700,000 acres, the building of hydro-electric power stations with an annual output of 2 billion kilowatt hours, irrigation and drainage systems and a modern network of waterways to link the busiest centers of the country. Workers are already being trained for the project while engineers put the final touches to blueprints.

A conservative estimate of the economic benefits to be gained from the interrelated river works amounts to more than 500,000,000 zlotys ($125,000,000) yearly in addition to advantages from improved communications, further electrification of cities and villiages, and the establishment of new raw material bases. Under the impact of the river reconstruction plans, part of a larger design to transform nature and use the country's natural resources to full capacity, the whole of Polish industry and agriculture will take a great step forward beyond the notable advances already made in the past few years.

At present less than half of Poland's approximately 3,000 miles of navigable rivers and canals are open to shipping. The 621-mile Vistula River is only open to large vessels for a stretch of 124 miles. Of the country's annual potential of 10 billion kilowatt hours from river resources only a small percentage is being used.

The chief feature of the new plans, evolved with the help of the Soviet Union's experience in hydro-electrical engineering, is that they will permit, in contrast to the haphazard prewar policy, multiple and interrelated utilization of water resources for various branches of the Polish economy at a low cost.

The point of departure for the river development program is the Vistula which will be made navigable over its entire course for vessels up to 1,000 tons. Hydro-electric stations to be built on the Vistula will have a total capacity of a million kilowatts while the irrigation system linked to it will supply water to almost 370,500 acres of the river valley.

The foremost canal construction project is the one which will connect the Vistula and the Odra and will run close to the main Silesian industrial basin. The canal is important to the Vistula as a waterway and of major importance to the Silesian basin itself. The Vistula will be able to carry to and from Silesia such heavy cargoes as coal, iron, non-ferrous metals, chemicals, building materials.

Another canal planned will run between Zeran, a Warsaw suburb, and the town of Zegrze, eleven miles away. In addition to serving navigation, this canal will shorten the route from the Bug River to Warsaw and help drain the marshy areas between the Praga district of Warsaw and the Bug valley. Factories on the outskirts of Warsaw will be able to use the canal for transportation and its water for manufacturing processes.

According to Tadeusz Borowy, Chief of the Hydro-Project Research Section, the river and water development program at the peak of construction will employ 75,000 workers, 1,000 engineers, and 3,000 technicians and supervisors.

—release from the Polish Embassy

Research Round-Up

A news section reporting latest technical developments at the University

In the May, 1948, issue of the CORNELL ENGINEER, Professor Carl W. Gartlein of the Physics Department wrote an article on his studies and findings on the aurora borealis phenomenon. During the past four years he and his fellow workers have made several additional discoveries.

Perhaps most important is the discovery that hydrogen is the primary particle in the aurora. When viewed with a spectroscope, all elements appeared as sharp lines except hydrogen, which was much broader. This broad line indicated that the hydrogen was in violent motion. Hydrogen sets up ionization, and this scattering from the element is what one sees as aurora.

To prove the hypothesis, two spectrographs were set up in 1950, one in Canada pointing up and one here pointing at the other. Proof was obtained when the spectrograph here showed the aurora pointing to the one in Canada.

By taking photographs simultaneously at Colgate University and here in Ithaca, the height and position of the phenomenon can be determined, using values of time and brightness to compute these two measurements. Knowing that waves in the ionosphere bounce on nights of aurora appearance, Professor Gartlein is now trying to synchronize the times of disturbance and of aurora.

He is also working in close conjunction with the research in the Electrical Engineering School on radio disturbance due to auroral effects.

Closely associated with the Physics Department's study of aurora is the work done by the Electrical Engineering school on similar projects. Under the direction of Dr. Booker and in conjunction with the Signal Corps, the work includes sending out radar signals and interpreting the resulting reflections of these signals.

The aurora is generally located about 100 kilometers above the earth; therefore, the size of it is approximately the size observed from the ground. The echoes received from a pulsed, 100 megacycle per second wave enables one to determine (from the time) the distance of the aurora and its direction from the radar.

A 50 megacycle wave, which has no pulses and therefore cannot measure distance, can through its echoes indicate whether the aurora is in motion. The frequency of the reflected wave is changed by the Doppler effect, and the return wave is not the one transmitted originally. In addition to measuring the relative motion, this method can measure the random motion of the phenomenon.

Further interesting studies are available through utilization of a Cedar Rapids-to-Boston, 50 megacycle beam, which comes close to Ithaca in its travel. The receiver here, pointed north in the direction of aurora, usually shows a weak signal. However, on nights of aurora, the beam is scattered. Thus the receiver indicates existence of any scattering in the north, usually due to aurora.

Most scattering is seen by this method at night or in late afternoon. The aurora is seen by human eyes only at night, but this does not preclude the possibility that it exists in the daytime. If the scattering is associated with aurora, that is, if the instruments correctly indicate when the aurora exists, it may be concluded that the aurora is largely a night phenomenon.

The study of scattering processes by pointing the instrument straight up has one major limitation: there are no echoes at frequencies greater than 30 megacycles. Here at Cornell a parabolic mirror has been built; simply, it is constructed as follows. Steel cables, between poles arranged in a ring 100 feet in diameter, approach a parabolic shape when tied down. Copper wires are fastened to the cables, parallel to each other, and a high-power pulse transmitter attached produces a 30-megacycle wave.

Another device used in this study is the ionospheric sounder. This radar-like device, pointing straight up, utilizes frequencies sweeping from 1 to 2.5 megacycles. The observer can determine all the reflecting properties of the ionosphere in this frequency range within a few minutes time.

Tube Improvement

Improving reliability of vacuum tubes is another research project being undertaken by the E. E. school. This endeavor, done under contract with the Applied Physics Laboratory of Johns Hopkins University, has three main phases: (1) Designing and testing "getterless" tubes; (2) measurement of microphonic properties of vacuum tubes; and (3) manufacture of experimental tubes for testing.

The first phase of this research consists of building tubes without getters. The getter is the silverish barium coating seen in most vacuum tubes; its purpose is to reduce pressure inside the tube by absorbing, adsorbing, or chemically combining with the gases in the tube.

Overcoming the big disadvantage of the getter is the reason for making tubes without them. This disadvantage is the getter's tend-

ency to evaporate when the tube becomes hot; then when it cools, the barium condenses on the insulating material, causing leakage. Tubes without getters must obviously be evacuated to considerable lower pressures than those with the additional metal.

Tubes constructed by the department without getters are now being tested to determine their change in characteristics with life. They are placed on a test rack with rated potential applied almost continuously.

Microphonics is the study of the variations in output current due to the relative motion of the elements in the tube: namely, the anode, cathode, and grid. The characteristics of plate current, amplification, and transconduction depend on the spacing of the elements. These variations due to the motion of the elements, range from a few millivolts up to 100 millivolts, quite important in our present day dependence on signals of vacuum tubes.

Testing for microphonics naturally involves subjecting the tubes to actual bouncing and bumping around. There are numerous methods for accomplishing this, both mechanical and acoustical. One mechanical method consists of mounting the tube in the usual manner and then tapping it at regular intervals with a pendulum tapper arrangement.

An acoustical method of producing vibrations is the use of a sound pressure chamber, in which the frequency of excitations can be varied over the audio range. In this device two speakers at a ninety degree angle to one another vibrate the tube mechanically throughout the whole audio frequency spectrum. Various indicating devices are used to observe or record microphonic data: peak-to-peak voltmeters, rms voltmeters, oscilloscope patterns, or brush oscillographs.

Finally, Cornell's research on tube improvement takes in the manufacture and testing of their own tubes. One matter being studied is the changing of a tube's dimensions, to bring microphonics to a minimum. Another is increasing the tightness of tube construction by mounting the elements more firmly in the mica insulators to reduce relative motion.

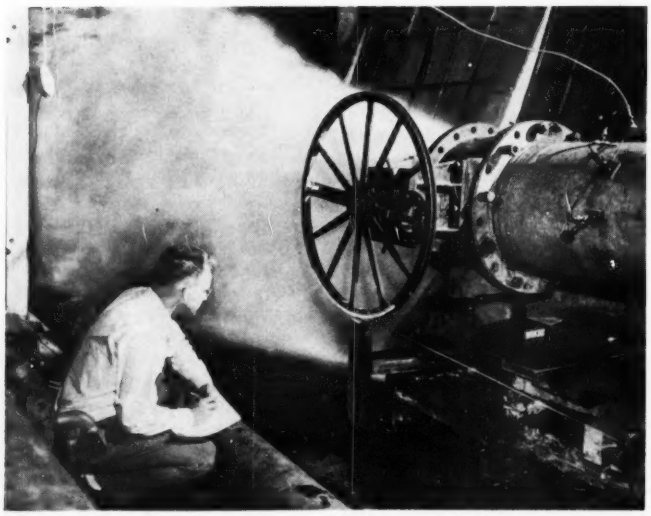
CE Projects

Unlike the other engineering schools at Cornell, the School of Civil Engineering does not schedule any project for the fifth year engineers. Instead, almost all of the research in the school is done by members of the faculty and by graduate students; many of the projects are sponsored by industry or the government.

This year a wide variety of research is being conducted in the fields of structures, hydraulics, and transportation. In the Structural Engineering Department, several projects are under way. One project under the direction of Professor P. P. Bijlaard, is being carried out for the Pressure Vessel Research Committee. The object of the project is to determine the effect of external loading on pressure vessels. Assisting Professor Bijlaard are Professor George Winter, Assistant Professor G. P. Fisher, and Mr. R. E. Mason. Another project, conducted by the school for the American Iron and Steel Institute, is concerned with the use of thin gauge steel in fabrication and building. This project is under the direction of Prof. George Winter. Research is also being done in the Structural Engineering Department on the analytical and experimental investigation of the buckling of rigid joint structures.

In the field of transportation there are several sponsored projects under investigation. Among these are: a project on beach accessibility and trafficability being conducted for the Navy, a project on the determination of soil moisture and density by nuclear material, and a project on long range photography for the Signal Corps. In hydraulics, flow metering devices are being studied for the Providence Builders, Inc.

Testing valves in the University's Hydraulics Laboratory.



Radio Astronomy

Part of the EE school's research in radio astronomy is a sun-watching project at Mohawk Airport, northeast of the Cornell campus. A special set of radar antennae are used for these observations.

These antennae collect the various signals emitted by the sun from disturbances such as sunspots. The signals are recorded by a brush pen and come through at a frequency of about 200 megacycles. Some signals are also received from a few stars and constellations.

One of the radar antennae turns only one revolution per day. It employs a one-twelfth horsepower motor which operates at 1800 r.p.m. This speed is reduced by a factor of two and a half million to give the

desired one revolution per day.

The project adds considerably to knowledge of audio waves and the heavens and provides information for the building of better radio equipment.

Hydraulics and Geology

Tests on two large valves, a 24-inch butterfly valve and a 20-inch Rotovalve, have been conducted in Cornell's unique Hydraulics Laboratory below Triphammer Falls on the University campus. Prof. Marvin Bogema of the Cornell School of Civil Engineering is pictured checking the disc angle on the butterfly valve which discharges 30 cubic feet per second directly to the atmosphere. The laboratory provides a gravity flow of 64 cubic feet per second under a working head of 50 feet. The R-S Products Corp. of Philadelphia and the S. Morgan Smith Co. of York, Pa., requested the tests to establish head loss coefficients and torque requirements for various valve positions, for the valves operating in the line as well as with free discharge.

A small-scale duplication of tremendous changes that occurred ages ago in the earth's crust is going on in the Mineralogy Laboratory at Cornell University. The attempt to create magnetite, an important iron ore, as it was formed by nature was described by Prof. William T. Holser of Cornell at the annual meetings of the Geological Society of America held in Boston recently.

The aim of the project is to find how much iron is dissolved in water at extremely high temperatures and pressures. Field investigations by Professor Holser and others in Montana and New Mexico indicated that iron was deposited under similar conditions in nature.

The work may give some long-awaited answers about the history of the earth, particularly about the relations among igneous rocks, metamorphic rocks, and veins, in all of which iron is a major component. It may also lead to a better evaluation of economically important iron deposits.

Test tubes for the experiments are bored from thick bars of nickel alloy. Samples of nature or artificial iron compounds and a large amount of pure water are placed in these "bombs," which are heated nearly red hot.

The water in the bombs rises to a pressure of more than 15,000 pounds per square inch. The density of this "steam" is more than half that of ordinary water, enabling it to dissolve some of the iron.

Measuring the amount of iron in solution takes highly sensitive analytical methods. Frequently as little as one part of iron to 20,000,000 of water is found in a sample as small as a teaspoonful.

The work began in a limited way more than three years ago. In April, 1951, it received one of the Geological Society's grants for basic geological research. Last June it received further support in a two-year contract with the Office of Naval Research as part of its program of pure science research.

Cosmic Ray Research

Preparations for cosmic ray research by Cornell nuclear physicists are nearing completion with the installation of a large electromagnet in a specially constructed moving van at Ithaca. From here the physicists, headed by Professor K. I. Greisen, will go to Echo Lake atop Mt. Evans in Colorado, where they will have optimum conditions to study cosmic rays. The cosmic ray research, supported in part by the Navy, is part of a larger program of basic research into the nature of high energy nuclear particles.

Specifically, the Cornell physicists will measure the energy of the very energetic particles which as yet cannot be generated in man-made machines such as Cornell's synchrotron. The best means to date of determining the energy of these rapidly moving charged particles is to measure the deflection of the particle as it passes through a strong magnetic field. As the strength and size of the field are increased, particles with greater kinetic energy can be investigated.

At Echo Lake, the Cornell physicists will use an electromagnet with a magnetic flux density of about 20,000 gauss. The field region has a two-foot by five-inch rectangular opening and a four-foot depth. The electromagnet weighs between 25 and 30 tons and is rated at 100 kilowatts. Associated with the magnet is the familiar cloud chamber which plots the path of the particle as it travels through the field region.

With the electromagnet, the physicists hope to measure particle energies up to two times ten to the eleventh power electron volts, or energies about one hundred times as great as any that can presently be generated by machine. Actually, very few cosmic particles have energies as high as this, nor are the present experimental conditions very satisfactory. For these reasons, the measurements on cosmic rays are regarded as a temporary method of studying high energy particles. More extensive research in this field promises to be forthcoming with the building of larger accelerators.

Reprinted from The Annual Report of the Smithsonian Institution for 1951

Atomic Energy in Industry

By M. L. OLIPHANT

Professor of Physics, University of Birmingham, England

Any attempt to forecast the ways in which atomic energy will be applied for the good of mankind is as unreal as to prophesy the future of a 5-year-old child. It is certain that the new source of power will be applied in ways that cannot now be envisaged. It is possible that a scientist who has spent his life in the study of nuclear physics and the unexpected and monstrous child to which it gave birth after 50 years as a purely academic discipline, is as much entitled as anyone to guess how it will develop in the years ahead, but as a parent of a "problem" child, he is an unlikely to guess correctly. Fortunately for me the blanket of secrecy that covers some aspects of development in this field has been pulled aside, by official declassification of information, by the report and news releases of the United States Atomic Energy Commission, and by the statements of American senators, sufficiently for a picture of the general lines of thinking and experimenting to be available.

Artificially Radioactive Substances

In the early days of public knowledge of atomic energy much was said and written about the great value of the radioactive byproducts in medicine, agriculture, chemistry, and other branches of scientific investigation. The advances in our knowledge of natural processes which can be gained in this way are very real, and scientists all over the world are using the materials made available through the American and British atomic-energy projects. However, the total amount of radioactive material required to satisfy all needs is so trivial in relation to what can be produced that it can provide no economic justification for the development of atomic energy. All the radioactive materials needed could be produced at a very small fraction of the cost by means of cyclotrons and other tools of nuclear physics; and their use in research was widespread and growing long before they were made available from atomic-energy reactors. Probably scientists were apt to stress the importance of these substances because their consciences were uneasy after Hiroshima and Nagasaki, and they welcomed an aspect of atomic energy, the humane and intellectual implications of which would offset some of the horrors of atomic warfare. Official releases of information used the facts about them because they were nonsecret and made a good story. These materials, which were available more than 10 years before the realization of the release of atomic energy, cannot justify the development of the atomic bomb or the colossal sums spent on atomic energy. Justification must, and I believe will, come from applications of atomic energy of immensely greater economic and industrial significance.

Industrial Power

The most obvious and the most important application of atomic energy that we can envisage at the moment is the production of industrial power. The tactical and strategic applications of atomic energy in warfare, some of which have received attention in the press, form no part of this lecture, for they are anything but economic and represent merely a diversion of effort from development of greater and more permanent human value. Accordingly, I shall not discuss such special problems as the use of atomic energy for the propulsion of submarines or for the acceleration away from the earth of the so-called "space ships" with which some enthusiasts propose to develop luxury holiday traffic between the planets. I propose to confine myself to the possibility of generating, in large fixed reactors, industrial power which is distributed as electrical energy.

The users of industrial power in factory, office ,or home, will notice no difference whatever from their present use of electricity derived from water power or coal. Atomic-energy reactors will merely replace the furnaces of power stations burning coal. The most noticeable difference at the generating station will be the absence of coal dumps, coal-handling equipment, coal wagons or barges, ash-disposal systems, and smoking chimneys. The boilers and steam turbines, the electric generators and other equipment will remain, though the boilers and turbines might later be replaced by heat exchangers and gas turbines. Thus the successful application of atomic energy will pass almost unnoticed by most people except that there may be fewer interruptions of supply; restrictions on the use of electricity may be replaced by a positive urge to use it, and electric clocks will really tell the time.

The cost of coal for the generation of electricity is only part of the cost of electric power. Where industrial power costs one penny for a kilowatt-hour, the coal will cost about one-third of a penny and the cost of generation and distribution will account for the other two-thirds. If the coal were free, the cost of electric power would be reduced by less than 30 percent. Distribution costs fall rapidly as the average load on a system increases. That is why electricity is cheaper in towns than it is in the country. Thus, the complete electrification of the country and the abolition of domestic heating by solid fuel would so increase the load factor on the distribution system that the cost of electricity would fall. If atomic fuel proves cheaper than coal, and we will see that this may well be the case, the price of electricity would be appreciably reduced still further.

What is Atomic Energy?

Since the nuclear consituents are very tightly bound together, addition of particles to a nucleus leads, in general, to a release of energy corresponding to this binding force. The energy released for every atom undergoing a nuclear transformation is a million or more times greater than the energy released in chemical combination. Thus, if the nuclei of 4 atoms of hydrogen could be made to combine to produce the nucleus of a helium atom, the energy released by 1 pound of hydrogen undergoing the reaction would be equivalent to 100 million kilowatt-hours, as compared with 3 or 4 kilowatt-hours produced by burning 1 pound of coal. We shall return to this possibility later.

The element uranium is the heaviest and most complex of the substances existing in the earth. When a neutron is captured by one of the two istopes of uranium, the transformations which take place differ from those occurring in other elements. The rarer isotope of mass 235 undergoes a process that is called fission, the energy released being about 10 million kilowatt-hours for 1 pound of U^{235} undergoing fission.

The U^{235} atom, after absorption of a neutron, splits into two atoms of simple structure and smaller mass, which separate with high velocity, their energy being dissipated as heat in the surrounding atoms with which they collide. In addition, several neutrons are set free, and if the surrounding material is also U^{235}, these neutrons will be absorbed and will produce several fresh fissions. Thus it is clear that in a mass of U^{235} large enough to absorb the neutrons from a fission process taking place at the center, a chain process can build up, and since the neutrons are moving with high velocity, the number of fission processes taking place multiplies with great rapidity. A mass of U^{235} in which this chain process will just take place is said to be of critical size, and the greater the extent to which the mass exceeds the critical size, the more rapid is the multiplication, so that if the critical size is exceeded appreciably an atomic explosion takes place. The critical mass for U^{235} is officially stated to be between 2 and 400 pounds, and since it is a very dense substance this corresponds with a sphere of metal less than 12 inches in diameter. Since the neutrons released with high velocity in the fission process are absorbed directly, a nuclear chain reaction of this type is called a fast fission process.

Fast Neutron Reactor

If the mass of uranium 235 consists of two pieces, either of which alone is smaller than the critical mass, and these are brought together slowly and cautiously, it is possible to find a position where the system is so little above the critical size that the energy release builds up very slowly. The two pieces of uranium metal will then be heated and we can arrange an automatic mechanism that pulls them apart if they get too hot or brings them together if they cool off, so maintaining them in a red-hot condition. The heat given off can be transferred to water or to gas and can be converted into useful power in a heat engine. This is the simplest type of nuclear reactor that can give useful power. However, there are a number of difficulties.

Uranium 235 can be separated from natural uranium, of which it forms 1 part in 140, only by very elaborate and expensive physical processes. Uranium metal is very active chemically and must be protected from attack by the cooling water or gas. Very large numbers of neutrons escape from the outer surface of the uranium, together with a quantity of radiation, akin to X-rays. These must be absorbed in thick shields of concrete to prevent lethal danger to living things in the neighborhood. The amount of heat that can be abstracted from pieces of metal with so small a surface is small, and in practice it is necessary to increase the cooling area greatly and use a larger mass of fissionable material. The problems of control must be solved in such a way as to eliminate all risk of explosion. The charge of U^{235} must be removed periodically and treated chemically to remove the accumulated fission products and to add fresh U^{235}, and this involves serious problems of engineering and of handling the highly radioactive material.

The principal isotope of uranium, U^{238}, behaves in a different way when it absorbs a neutron. Instead of undergoing fission it changes, by a process involving the radioactive emission of two negative electrons, into a new chemical element, with 94 protons in the nucleus, which has been called plutonium. This substance, which does not exist in the natural state, is a metal that changes to U^{235}, but this change is so slow, requiring 10,000 years or more to be half completed, that for all practical purposes plutonium is a normal metal. It undergoes fission when it absorbs a neutron of any energy and hence can replace U^{235} as a nuclear fuel.

Slow Neutron Reactors

The capture of neutrons by the much more plentiful U^{238} prevents the establishment of a chain process with natural uranium. There is, however, an ingenious way out of this difficulty, which enables reacting systems to be built using natural uranium. U^{238} does not capture neutrons that are moving with less than a certain minimum velocity. Neutrons can be slowed down by passage through materials like pure carbon or heavy water, which do not absorb neutrons at all readily. The particles then make collisions with atoms of carbon or of heavy hydrogen, handing over to the struck atom at each collision a part of their energy. By placing rods of uranium in a geometrical pattern, which can be calculated, in a mass of pure graphite, it is possible to arrange that fission neutrons escaping from the relatively thin rods without appreciable absorption wander around in the graphite for a considerable time, making many collisions and losing most of their velocity. When they do again wander into a uranium rod they are, in general, moving too slowly to be absorbed by the U^{238}, and hence ignore it. However, they are very readily captured by the rarer U^{235} atoms, giving rise to fission.

In order that a chain reaction may be produced, a slow neutron reactor of this type must also be above a certain size, where the number of neutrons lost from the outer surface is less than half the number generated within the pile by the chain reaction. The critical size is large and even a small neu-

tron reactor will contain many tons of uranium and hundreds or thousands of tons of carbon as pure graphite. The neutrons escaping from the outer surface are, to some extent, reflected back by a thick layer of graphite placed around the reactor, while the remainder, together with the accompanying X-rays, which are so harmful to living matter, must be absorbed in the walls of a massive concrete enclosure. The energy set free in the fission process in the uranium rods appears as heat, which can be removed by passing gas or water over them. Here again it is necessary to coat the uranium with a protective layer of corrosion-resistant metal that does not absorb neutrons readily, aluminum being employed at present in the absence of a better material.

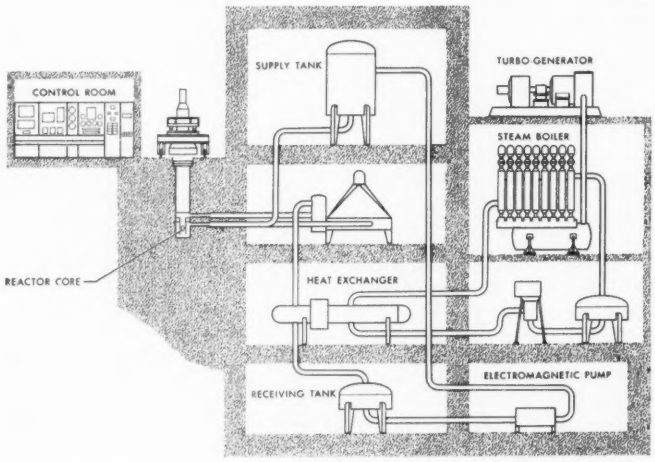
The slow neutron reactor has some advantages over the fast neutron reactor, but it suffers also from severe limitations which are not present in the fast reactor. The large mass and surface of the uranium allows very large quantities of heat to be extracted, so that the total power output of a large reactor can be of the order of 1 million kilowatts of heat. However, it is not yet practicable to remove this heat at a temperature high enough for efficient heat engines to be operated from the steam or gas which carries away the energy. This is due to the limited corrosion resistance of aluminum. The development of coatings of beryllium, or the use of less reactive gases such as helium, for cooling, would permit the production of useful power, but no reactor is yet operating under these conditions. There are also other grave difficulties due to the changes in the properties of materials under the action of fast neutrons. These technological problems will be solved, but they take time and great effort to achieve a completely satisfactory answer. A far more serious problem is that in a slow neutron reactor it is possible to use only a small fraction of the U^{235} present in the rods. Inevitable impurities in the materials and the accumulated products of fission "poison" the reaction by absorbing neutrons. The former set a lower limit to the concentration of U^{235} in the rods at which the reactor will operate, and this is only slightly less than the concentration in natural uranium. The uranium must be removed periodically and be subjected to an elaborate and costly chemical process involving solution of the rods in acid, chemical purification, and reduction to metal again. The whole of the initial chemical operation must be carried out by remote control in concrete or lead enclosures which absorb the harmful radiations coming from the highly radioactive fission products. These fission products, equivalent in activity to many tons of radium, must be disposed of in some way, and this is one of the most difficult problems of all. If they are thrown down a disused mine or buried they may reappear in the underground water supply with disastrous results. The uncertainty of ocean currents renders it hazardous to dump them into the sea, even into the deep sea when sealed in containers. The radioactivity decays away in time, some of it relatively quickly, some much more slowly, so that if the fisson products are stored in vats underground they will, in the course of a generation or two, become harmless. However, the storage capacity required to deal with the radioactive waste products of a large reactor is so huge that provisions of the necessary underground vats becomes an immense undertaking.

All these difficulties are very real and must not be underestimated. However, they are technological difficulties with which modern applied science is accustomed to deal, and are none of them insuperable. Their solution is certain of the necessary effort is made, and many of them are being attacked vigorously in both America and Great Britain; though in the present state of international tension, they must take a position subordinate to the development and manufacture of atomic weapons.

If a nuclear reactor is operating at a constant power level the number of fissions taking place each second must be constant. In the systems we have considered so far the number of fissions taking place in 1 second must increase rapidly. We have indicated that a fast neutron reaction can be controlled by moving the component parts so that more or less of the neutrons escape from the surface. This control is rendered easier because some of the neutrons set free escape a fraction of a second after the fission process itself. This means that if the system is just larger than the critical size, the multiplication proceeds rather slowly. The component parts of a slow neutron reactor are too large and bulky to be moved this way, so the system is controlled by pushing into the interior of the reactor rods of cadmium or of boron, which have the property of

Schematic diagram of atomic breeder reactor. Gray borders indicate concrete shielding enclosing the core and primary cooling circuit.

—Scientific American



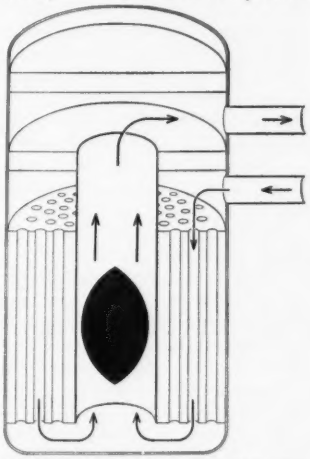
absorbing neutrons readily, so robbing the chain process of the number of neutrons required to keep it going. There is no difficulty about controlling completely the rate of energy release in a reactor, so that the chance of the process running away and giving rise to an explosion is so small as to be entirely ruled out. Very elaborate precautions are taken to prevent the escape of radioactive materials or of harmful radiations, and workers in an atomic-energy plant and those who live in the neighborhood are not subjected to any abnormal risks.

"Breeder" Reactors

The picture of the production of atomic energy for industrial purposes that we have drawn so far is not encouraging. The fast neutron reactors require rather concentrated fissile material as atomic fuel, and this is very difficult and expensive to produce. The slow neutron reactors utilize only a very small fraction of the rarer isotope of uranium and produce about the same quantity of plutonium. Much more than this must be achieved if atomic energy is to compete successfully with coal as a source of power. Fortunately the way out is clear, though it has not yet been achieved in practice, and the solution brings with it the possibility of using thorium, as well as uranium, as a nuclear fuel.

On the average a fission process releases several neutrons, say three. If it is assumed that there are in the reactor no impurities or materials of construction (other than uranium) that absorb neutrons, the three fission neutrons can be utilized in the following way. At constant power output one of these neutrons must produce a fresh fission by absorption into the nucleus of another fissile atom. A second neutron can be captured by uranium of mass 238 to produce an atom of plutonium, thus replacing the atom of fuel that has been used. The third neutron can be absorbed by a second U^{238} atom giving another plutonium atom. Thus a reactor operating in this way should produce more nuclear fuel than is burnt and is called a "breeding" reactor. The breeding process should make it possible to utilize the whole of the uranium, the plentiful U^{238} as well as the scarce U^{235}. If the excess neutrons are absorbed in thorium instead of U^{238}, a new fissile material which can replace U^{235} or plutonium is produced by a process very similar to that which produces plutonium.

The thorium nucleus absorbs a neutron producing a radioactive isotope of thorium of mass 233. This emits a negative electron, or β-particle, transforming into a radioactive form of protoactinium, which emits a further β-particle to give an isotope of uranium of mass 233. U^{233} is a fissile substance which can be used as a fuel in nuclear reactors. Thus, in time, it should be possible to change over from uranium to the more plentiful thorium as fuel for the production of nuclear power.



Chain-reacting core (oval in center) supplies neutrons to surrounding U-238 in breeder reactor. Liquid metal coolant flows through core and emerges at high temperature. —*Scientific American*

The design of a successful breeder reactor depends upon the elimination from the reactor of materials that capture an appreciable fraction of the neutrons without contributing to the production of power or of fresh fissile material. There are reasons why this may prove to be more practicable with the fast neutron reactors than with those using slow neutrons, partly because the smaller mass of fissile material in the reactor can be prepared in a state of higher purity, partly because there is no moderator, but principally because the essential materials of mechanical construction and the cooling fluid which can be used in a fast neutron reactor are not so restricted in properties. The most important of the factors to which answers have yet to be found is the extent to which the materials in the reactor retain their normal physical properties when the atoms of which they consist are continually stirred up and knocked out of place by collisions with fast neutrons.

The Atomic Energy Commission in the United States has announced the construction of two types of experimental breeding reactor and a materials-testing reactor. The first of these is designed to test the practical feasibility of breeding with fast neutrons and to investigate the application of liquid metals to the removal of fission-produced heat at high temperatures. The second will produce significant amounts of electric power from a reactor using neutrons in the intermediate range of energies, and at the same time will determine whether breeding is possible under these conditions. The heat will be removed with liquid metal, and power will be generated from this by conventional means. These breeder reactors, together with the material-testing reactor, are estimated to cost about 70 million dollars. The Ministry of Supply has not yet announced plans in Britain for work on breeder reactors upon which the future of atomic energy for useful purposes clearly depends.

Economic Cost of Nuclear Power

It is not easy to estimate, as yet, the economic cost of nuclear power. The energy derived from 1 pound of uranium, completely utilized in a breeder reactor, is equivalent to that produced by burning 1,500 tons of coal. The cost of uranium is about 1,000 times the cost of coal. This leaves a factor of about 3,000 to cover the cost of converting the uranium to a form suitable for use in a reactor and the greater cost of a nuclear reactor over a coal furance. In the absence of precise data it is possible only to guess the ultimate answer. You will find that many British scientists and engineers of repute believe that the cost will always be too great for atomic energy to compete with coal as a source of power, and that the form of energy is of purely military and scientific interest. I do not share this view. I feel confident that

atomic energy has a very important part to play in the production of industrial power and that the cost will ultimately be found to be competitive with, and probably much less than, the cost of power from other sources. The time required to reach this stage of development is unlikely to be less than 10 to 15 years and clearly it depends on the relative efforts devoted to the military and industrial objectives. Uranium is more widespread in occurrence than was thought to be the case and, with the development of methods for extracting it from low-grade ores, there should be sufficient available to provide a great contribution to the power resources of the world if it is not used for the manufacture of military weapons.

Hydrogen As A Nuclear Fuel

Finally, we must consider the possibility that industrial power may one day be produced from hydrogen. Long before the discovery of the fission process it was realized that under conditions of extremely high temperature and pressure, such as exist in the interior of the sun and stars, hydrogen nuclei, or protons, might combine to give nuclei of heavier elements, and that because the component parts of heavier nuclei are very tightly bound together, sufficient energy would be released to maintain the temperature of the star. If it were possible to find a method by which heavier atoms could be synthesized from hydrogen at will and under controlled conditions, very large amounts of energy would be available. Thus, if four atoms of hydrogen condense to form an atom of helium, the energy set free is about 5 million times as great as that produced when an atom of carbon is burnt. In other words, 1 pound of hydrogen transformed into helium would produce about 100 million kilowatt-hours of heat energy, or about 130 million horsepower for an hour. Thus hydrogen as nuclear fuel would be about 10 times as good, weight for weight, as uranium. There are possible ways in which an explosive reaction of this type can be produced by utilizing the very high temperature and pressure developed in the explosion of an atomic bomb, but so far there is no clue to a method for bringing about the reaction in a controllable way. However, it is interesting to speculate on the possibility that nuclear scientists may discover how to do this in the future.

There is enough hydrogen in the sea, if it were all converted into helium, to raise the temperature of the whole earth to at least 1,000,000° C., or over 100 times the temperature of the surface of the sun. Fortunately for us the possibility of bringing about such an explosion can be ruled out, if for no other reason than that if it were possible it would have happened in the past history of the earth. However, if we accept as the desirable power level for civilization, that every individual should utilize, on the average, 1 kilowatt of power continuously, we can calculate that 3,000 million inhabitants of the earth could be supplied with power from the hydrogen of the sea for 1,000 million million years, or about a million times the age of the earth itself. Thus, if this remote possibility is realized, mankind would have no need to look elsewhere than to the sea for all the power he can conceivably use in the lifetime of the solar system.

In conclusion I would emphasize that industrial power from uranium is on the doorstep and will almost certainly be used successfully, while power from hydrogen is only a remote possibility in the light of existing knowledge. In any case, the probability is small that any nuclear power will be available for useful purposes unless the problems of war can be solved, and this is a question for all mankind and not for the scientist alone. There is danger in all knowledge of nature. Scientific information can always yield guns as well as butter. It is a source of great regret to men of science that their work is made the basis of the indiscriminate destruction of man and his civilization, instead of contributing to the well-being of all.

Final Answers to Brain Teasers

To the Editor:

Re: October Brain Teaser

* * * The census taker, though still in doubt about the ages, * * * asked one more question before he determined the solution: i.e., whether the taciturn gentleman was the oldest of the four residents. This indicates that two of the possible sets of answers will total the same number, the house number. Upon checking, it will be found that only the two sets (81, 8, 2) and (72, 18, 1) will have the same total, 91. Therefore, since the census taker received a positive reply to his final question, it is obvious that the correct set is (72, 18, 1) and that the age of the man answering the census taker is between 73 and 81.

Now, with careful study, it may further be deduced that, if all the occupants are related, the relationships and ages must be as follows:

Relationship	*Age*
Grandfather	73 to 81
Grandmother	72
Granddaughter	18
Great-Grandchild	1

Yours very truly,
A. W. Dauer, Ch.E. '48

Answer to December Teaser

The solution lies in the application of two simple rules taught in a course in arithmetic on the subject of factoring.

1. All numbers and only those numbers, the sum of whose digits is divisible by 3, are divisible by 3.
2. All numbers and only those numbers, the sum of whose digits is divisible by 9, are divisible by 9.

Since 15 is divisible by 3 and not by 9, all numbers, the sum of whose digits is 15, contain 3 once and only once as a factor and therefore cannot be a perfect square.

This same problem could be applied also to 12, 21, 24, 30, 33, 39, etc.

MEET YOURSELF— 10 YEARS FROM NOW

Ever wonder what you'll be like when the class of '53 holds its 10th reunion? If you started to work for one of the Bell System telephone companies after graduation, we can give you a pretty good idea.

POSITION IN THE WORLD: On the way up! A Development Engineer with the Bell Laboratories. Perhaps exploring the application of fundamental new electronic inventions to telephone communications. A Transmission Engineer, helping to provide the telephone needs of an entire state. A Supervisor in the Traffic Department, responsible for the speed and quality of local and long distance service in several cities and for the personnel relations of a large number of employees. In the telephone company, jobs such as these are held by relatively young men and women.

FUTURE: Unlimited! The Bell System continually progresses and expands and its personnel grows with it. In the past 25 years, the number of telephones has almost tripled. In the past 5 years, telephone companies have introduced such things as network television transmission, radio-telephone service and dialing of Long Distance calls. And the best is yet to come.

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K. J. Nelson

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

The application of atomic energy for peace-time use to compete with conventional fuels and energy sources presents a most challenging problem in technical development, economics, and legal study. Some of the major factors in its use for power generation were discussed by Mr. Walker L. Cisler, Trustee of the University and President of Detroit Edison Company, in his interesting talk on "Economics of Atomic Power" at the Society's meeting in New York on December 4.

Up to the present time atomic energy has been used solely for weapons. All activities are closely controlled by the federal government. However, considerable study is being made by industrial companies and the government on how private enterprise might participate in developing constructive uses for this new energy source. Each of four private groups has recently made a report to the Atomic Energy Commission outlining a suggested basis for participation and possible program for commercial development.

As an illustration, the Dow Chemical and Detroit Edison Companies have joined forces with several other private concerns to explore the possibilities of developing and constructing an atomic reactor for the steam generation section of a power plant. The potential project involves the development of a high temperature, breeder type reactor. It will produce high temperature, high pressure steam utilizing the heat released by the fission of uranium 235. In addition, it will produce as an important by-product, plutonium, which after recovery will be sold as a high grade atomic fuel. Plutonium should be a premium fuel for propulsion and for supplying heat requirements in certain process industries. The generation of steam from such a reactor is expected to involve appreciably higher investments than for conventional equipment, but this must be offset by lower operating costs and credits from the sale of high grade atomic fuel.

Detroit Edison is constructing at St. Clair a new conventional type power plant having a rated capacity of 625,000 K.W. using coal as the fuel. The steam generating section of this plant represents an investment of about $77 per kw and delivers steam to the throttle valve at a total cost of about 58c per million BTU's, including a 10 per cent fixed charge. If it is assumed that these operating costs can be capitalized at 10 per cent and that the atomic steam generating plant would require no labor, maintenance, or fuel, the latter could justify an investment of about $227 per kw. This investment would be reduced if any operating costs are incurred. Conversely it would increase in relation to the by-product credit received. These figures serve to illustrate the economic area within which the project must fall to be competitive.

If such a development is successful it will probably be applied initially in new power plants where the cost of conventional fuel is high. If replacement of existing facilities should ever become economc, it might displace conventional equipment representing about 45 to 50 per cent of the investment in the power plant.

K. J. NELSON.

* * * *

Cornell Engineers and their guests are cordially invited to attend the Society's Dinner Meeting in New York on the evening of January 21, 1953, which will occur during the week of the A.I.E.E. annual meeting. Our speaker will be Dr. Melvin De Chazeau, Acting Dean of the School of Business and Public Administration at Cornell. Reservations can be made through Mr. William Leonard, 4 Irving Place, New York 3. Telephone Gramercy 3-5600, Ext. 4336.

Gustavus A. Kositzky, M.E. '05, is a consulting engineer for the Brazilian Telephone Company, Rio de Janeiro, Brazil.

Robert H. Knowlton, C.E. '06, is chairman of the board of Connecticut Light and Power Company. His home is at 36 Westwood Road, West Hartford 5, Conn.; he has four married children and seven grandchildren.

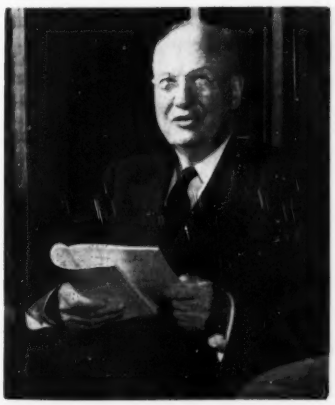
David Herrick Goodwillie, M.E. '08, died at his home on October 17. Manager of the Ford Glass Company in Toledo, he became executive vice-president of the company in 1931. He had retired last May and was a consultant to the glass industry. He served for two years as president of the Toledo board of education and as director of the Institute of Medical Research and of the Commerce National Bank. He had three sons, David, John, and Robert, all Cornell graduates.

Paul O. Reyneau, M.E. '13, director of the New York office of the University Placement Service at the Cornell Club of New York, 107 East Forty-eighth Street, died unexpectedly on December 1. His home was in the Orienta Apartments, Mamaroneck.

Reyneau was known to many alumni through his years of work in the New York Service office; he helped Cornellians to find jobs, not merely by introducing them to prospective employers, but by counseling with them as to their aptitudes and helping them to present their qualifications to employers. The Cornell Club of New York set up in 1932 the employment service which later became a branch of the University Placement Service. Reyneau became director in 1934.

Before joining the placement office, Reyneau was successively a distribution engineer and assistant electrical engineer with Detroit Edison Co., a consulting engineer with American Gas Co., Philadelphia, Pa., and technical information representative for Western Electric Co., New York City. He had been secretary-treasurer of the Cornell Society of Engineers since 1938, was a member of the executive committee of the Class of '13, and served as chairman of the men's committee for New York City interviewing applicants for Cornell National Scholarships. He was a member of Telluride Association and of Eta Kappa Nu and was a life member of the American Institute of Electrical Engineers. He was formerly a consulting editor to **Electrical World** and was the author (with H. P. Seelye) of **Economics of Electrical Distribution,** published in 1922, and of many technical and semi-technical articles. A native of Paris, France, he entered Sibley College in 1910 from Telluride School in Olmsted, Utah, and received the mechanical engineering degree in 1913.

Oliver E. Buckley, Ph.D. '14, chairman of the board of Bell Telephone Laboratories, Inc., retired this fall after thirty-eight years of service. He is a member of the Engineering College Council. In 1914 he joined Western Electric Co. as a research physicist and during the next ten years was in direct charge of the 1924 cable from New York to the Azores, which had a message capacity four times greater than any previous cable. He joined Bell Laboratories as assistant director of research. In 1940 he joined the communications and guided missiles division of the National Defense Research Committee, for which work he received the Medal of Merit. Since 1948 he has been a member of the general advisory committee of the Atomic Energy Commission, and in 1951 he was appointed by President Truman as first chairman of the science advisory committee of the Office of Defense Mobilization.



Oliver E. Buckley

William Ray Culbertson, M.E. '14, died on October 29, 1952. Since 1932 he had been with Rust Furnace Company, and in 1945 he became vice-president. He is survived by his brother, George T. Culbertson '15.

Eduard Fritz, Jr., C.E. '20, a civil engineer with Pennsylvania Water and Power Company, is on loan to "DEPA" as consultant in Washington, D.C. He lives at 215 Cedarcroft Road, Baltimore, Md., and has two daughters, one of whom is Eleanor Fritz Bowers, '50.

Richard B. Steinmetz, E.E. '22, is vice-president in charge of manufacturing operations for Anaconda Wire and Cable Company, Hastings-on-Hudson 6.

Julian Laurance Woodword, M.E. '22, died at his home, 417 Park Avenue, New York City, on November 4. He was a research executive with the Elmo Roper Surveys. From 1927 to 1946, he was professor of sociology at Cornell. He was the co-author of **Introductory Sociology,** published in 1937 by J. B. Lippincot, and past president of the American Association for Public Opinion Research.

Harrison P. Hood, Ch.E. '18, was recently awarded a John Price Weatherill Medal from the Franklin Institute in Philadelphia. His award was for the "discovery of

Harrison P. Hood

a truly novel process for the manufacture of unusual high silica glass. . ." of great stability and high softening temperature. Mr. Hood has been a research chemist at the Corning Glass Works since 1920.

Professor Allen K. Booth, C.E. '26, has been elected to the board of directors of the American Society of Civil Engineers. He is at present associate director of extension education at Rensselaer Polytechnic Institute. His home is at 2 Bolivar Avenue, Troy.

L. Irving Woolson, M.E. '26, has been elected president of DeSoto Motor Corp. He and Mrs. Woolson (Helen Chappell, '26) live at 750 Glengary, Birmingham, Mich.

William L. Cressman, C.E. '27, was recently appointed deputy director of the iron and steel division of the NPA. He is at present on loan to the National Production Authority, Department of Commerce, from the position of manager of eastern sales of Armco Steel Company, Middletown, Ohio.

J. Mauricio Alvarez, C.E. '29, was secretary of state and public works in the government of President Trujillo, Dominican Republic, until this year, when he resigned to do building, bridge, and highway construction as a contracting engineer. His address is Avenida France Bido, Santiago, Rep. Dominicana, W. I.

Baird T. Bauder, M.E. '40, has been promoted to production engineer of Minneapolis-Honeywell Regulator Company. He and his family live in a new home at 2404 Moreno Drive, Los Angeles 39, Cal.

Forrest L. Griffith, B.S. in A.E. '40, has left Connecticut to become assistant to the general manager of Hewitt-Robins Corporation, manufacturers of heavy duty materials handling equipment. His new address is 43 Aubrey Road, Upper Montclair, N. J.

H. A. Berker, B.M.E. '41, M.M.E. '42, 13220 Woodward Avenue, Highland Park, Mich., is working in the special research projects department of the Chrysler Corp., engineering division.

Robert J. Gairing, B.M.E. '44, is head of the sales department of Wadsworth Foundry Company in Wadsworth, Ohio, where he lives at 141½ Third Street.

Joseph Kissick, Jr., B.M.E. '46, is the assistant chief engineer of Copes-Valcan Division, Continental Foundry Machine Company. His address is 23 Chautauqua Boulevard, Erie, Pa.

Samuel Sailor, B.C.E. '48, M.C.E. '52, is now an instructor in the College of Engineering at Rutgers University. He and his wife, (Francis Wright, '48) live at 171 Bevier Road, University Heights, New Brunswick.

Donald D. Haude, B.C.E. '49, recently entered the employ of Seele, Value, and Knecht, civil engineers in New York City. His address is 6 Dell Lane, Wantagh.

Stephen B. Profilet, B.E.E. '49, announces the birth of his first son, Stephen, Jr. Lieutenant (j.g.) Profilet intends to do postgraduate work at Rensselaer Polytechnic Institute in the spring. He is now stationed in the public works department, Naval Air Station, Moffet Field, Cal.

George E. Griffith, B. Ch.E. '49, is another Cornellian in Latin America. He recently assumed the new job of factory superintendent of the Venezuelan plant of Colgate-Palmolive. His address is Apartado Postal 2617, Caracas, Venezuela.

Robert P. Liversidge, Ch.E. '32, was elected vice-president in charge of electric operations for Philadelphia Electric Co. Liversidge joined the company on graduating as

Robert P. Liversidge

an engineering assistant. In 1942 he was appointed superintendent of the Barbardos generating station. He was appointed assistant general superintendent of station operations in 1949, assistant manager of electric operations in 1951, and manager a year ago.

William C. Atkinson, B.M.E. '50, is an engineer and designer for Henry Dreyfus, industrial designer, 4 West Fifty-eighth Street, New York City.

Faculty Profile

Professor Erik K. Henriksen

By DAVID SCHERAGA, ME '54

Metals and Metals Processing comprise his field and the chances are that few men today are more familiar with this phase of engineering than Professor Erik K. Henriksen of the Materials Processing Department. Engaged in productive research for the past 20 years, both in his native Denmark and here at Cornell, he has long been recognized as an authority on machine tools and the mechanism of metal cutting.

Professor Henriksen was born and lived the greater part of his life in Denmark. His engineering career began upon graduation from the Royal Danish Technical University in Copenhagen with the degree of M.Sc. in M.E. He left his native country to travel abroad in Belgium, England, and Germany and then returned in 1928 to enter industry, doing work on locomotives, diesel engines, steel structures, and cranes. The year 1932 was important for him in that it brought him back to the Royal University as Associate Professor of Mechanical Engineering, thus laying the foundation for his future research activities. Starting out in machine tools, his field of teaching was gradually increased to metals processing, production methods, and industrial engineering, with the emphasis on machine tool design, operation analysis, and factory layout. It is interesting to note that he has made extensive studies into scientific management and methods engineering in addition to the work that he is probably best known for. Among his many publications are to be found papers on time and motion study, setting wage rates, economic lot size, and factory layout.

Surprisingly enough, World War II did not seriously hinder his work, and life at the university continued without much interference from the Germans. He notes, however, with a slight smile, that the students were decidedly "extra-curricular" during this period and often seemed sleepy in their morning classes. Except for serving as advisor to the Danish Government on air raid precautions, before and during the war, there was little change in his routine.

In the fall of 1947, Professor Henriksen made a three-month visit to engineering colleges and industrial plants in the United States. While here he met a member of the Cornell engineering faculty which soon led to his acceptance of a professorship as head of the Department of Materials Processing. Since coming to Ithaca in 1948, he has become a familiar and popular figure about Sibley and Rand Halls. Those who know him would describe him as being jovial, easy to converse with, and the possessor of a ready wit. Physically, he is of medium height, heavy-set, and dynamic in nature, especially when putting a point across in lecture. He is fluent in three languages, English, German, and the Scandinavian tongues and has a good reading knowledge of French. This particular talent led to his appointment as German language examiner for graduate students in engineering.

When he came to Cornell, Professor Henriksen lost little time in broadening the research program in Materials Processing. At present he is devoting a good deal of energy

to a cutting tools project, the purpose of which is to establish the most efficient design of chip breakers. He can often be seen at his experimental setup in Rand Hall surrounded by pans of carefully selected blue-grey metal chips. When the project is completed, its results will be published in the form of a manual on chip breaker design and operation. At the same time he is also investigating the residual stresses in metals due to machining, a field in which he has written many papers and is acknowledged an expert.

A tireless worker, he has spent much of his own time building up personal relations with the machine tools industry. This has resulted in increased industrial sponsorship of research at Cornell and also the donation of many valuable items of equipment to the University's laboratories.

As one who always liked to travel, Professor Henriksen has been doing his best to see the United States and Canada, taking his family (he has one son) on automobile trips across the country whenever he can get away (the family car has covered nearly 50,000 miles in the past four years). Another favorite avocation of his is writing. He is co-editor of several books and journals and, needless to say, his own work has kept him well supplied with material for the technical literature. For the past two years he has been busy with plans for the new Materials Processing Laboratory in Kimball-Thurston Halls, whose expanded facilities promise to keep him quite active at Cornell for some time to come.

Book Review

By CHARLES DUNNETT

SAMPLING INSPECTION BY VARIABLES *by Albert H. Bowker and Henry P. Goode. McGraw-Hill Book Company,* 1952. $5.00.

This book deals with the problem of inspecting a lot of manufactured items or raw material when the quality of each item depends on one or more characteristics which are capable of measurement. It is assumed that for each measurement a limit is specified which determines whether or not an item is defective. It is also assumed that the acceptability of the lot depends upon the percentage of items in it that are defective.

A comprehensive set of sampling plans is presented, designed to cover a wide range of practical applications. The plans are based on the calculation of the mean and standard deviation of the observed measurements, as opposed to the more widely used attribute plans which consider only the observed count of the number of defective items in the sample. For each plan, a chart is drawn showing its operating characteristic curve so that its control over lots varying in percentage defective can be judged. The plans have been chosen to correspond to the attribute sampling plans presented in the Columbia University Statistical Research Group book, *Sampling Inspection.*

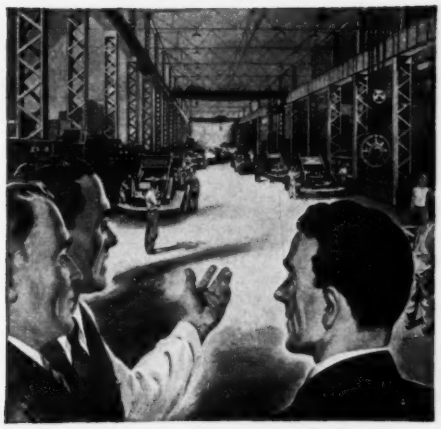
Although primarily written as a manual for those who are actively engaged in the field, the student who is interested in pursuing this type of work will find the book worth reading. The general principles of sampling inspection by variables are described in a lucid manner, and the construction of the sampling plans and the mathematical theory behind the techniques are covered in the later chapters. One feature of the book is the author's treatment of the situation where there are both upper and lower limits specified for the measurement.

Charles Dunnett

The plans are based on the assumption of a normal distribution for the quality characteristic of the items in the lot. The authors advise that the underlying distribution should be investigated before applying the plans, and a scale of measurement adopted so that the distribution is at least approximately normal. In the reviewer's opinion, the authors do not sufficiently stress the effect of non-normality on the operating characteristics of the inspection procedure. It is possible that even a slight departure from normality may so alter the shapes of the distribution in the "tails" that the very small percentages defective, with which most of the plans are concerned, may be altered considerably from that specified by the normal distribution, thus distorting the operating characteristic curve. In this situation, it may be advisable to use one of the attribute plans presented in the SRG book.

One other minor criticism concerns the authors' recommendation, when more than one measurable characteristic is involved, that the acceptance criterion be applied to each characteristic separately. The reader should be warned that this would have the effect of altering the operating characteristic curve of the combined procedure by lowering the probability of the lot being accepted.

The reviewer is a member of the Statistics Center, Cornell University.



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For nearly 70 years now we've been working with and for engineers, and by this time we feel we know something about them — and you. For example, we know that you're probably looking for a job that will let you and help you learn and grow. You want a chance to prove that you can *create*, engineering-wise, and that you can handle responsibility. You want security, but not the kind that means a safe, dull rut.

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Prominent Engineers

Although Andy Mellen's original plan was to study in the College of Arts and Sciences here at Cornell, he decided to transfer into Chemical Engineering during a visit to Cornell while he was in his senior year of prep school. That decision certainly was well made, judging from his outstanding career as an engineer. Andy's home is in Orange, New Jersey, and he attended Exeter for two years before he came to Cornell.

As a holder of a Cornell National Scholarship, Andy Mellen has lost little time in showing reason for the award, both in the excellence of his work and his extra-curricular activities. He is now president of Tau Beta Pi, engineering honorary, chairman of the Interfraternity Council Deferred Rushing Committee, a member of Pros-Ops honorary for chemical engineers, and a member of the American Institute of Chemical Engineers. Andy is an active member of Chi Psi Fraternity and was its president during his fourth year. He has also been

Andy

president of Sphinx Head honorary for senior men, chairman of the freshman campus orientation program, and a member of the *Widow* business board. Andy has demonstrated his ability as a chemical engineer with a top-flight scholastic record and has been on the Dean's List several times.

During his summer vacations, Andy has been with the Esso Technical Service Division at Bayway, New Jersey, and has done research work with the Socony-Vacuum Company at Paulsboro, New Jersey. Although he has been working with petroleum companies in his vacation time, Andy is not exclusively interested in that phase of the chemical industry. Work in economic evaluation in the chemical industry is the field to which he is looking for a career. Andy's immediate plans upon graduation involve the United States Air Force; he will receive his reserve commission this June in the armament option. Whatever Andy Mellen's activities should be in the Air Force and in his work in the chemical industry, we are sure that they will be as successful as his life at Cornell.

Walt Harrison, EP '53

When Walt Harrison graduated from DeVilbiss High School in Toledo, Ohio, he intended to study Mechanical Engineering at Cornell and entered Cornell as a student in that department in the fall of 1948. Soon after arriving on the campus, however, Walt found that he was more interested in the studies offered by the Department of Engineering Physics. As a result, the EP department had a new member the following spring term.

From the very beginning of his career at Cornell, Walt's scholastic record has shown his enthusiasm and ability for his studies. He has been on the Dean's List continually as a result of his outstanding work. When Walt came to Cornell, he was the holder of a two-year Undergraduate Scholarship, and he later became winner of the Delta Upsilon Leadership Scholarship Award. It is evident that this man has let no grass grow under his feet. Walt is a member of Tau Beta Pi, and is vice-president and rushing chairman of that organization.

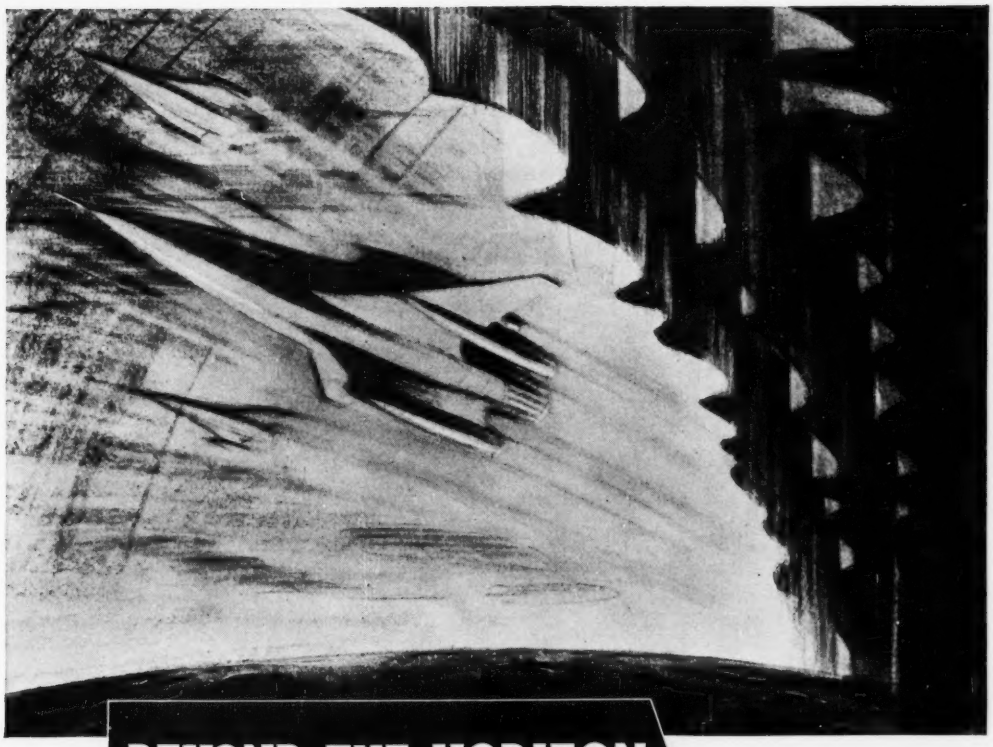
The extra-curricular phase of Walt's university life is no less impressive than his academic achievements. He is an active member of Delta Upsilon Fraternity and was elected to the office of president which he held during his fourth

Walt

year. During his third year at Cornell, Walt must have been one of the busiest men on campus. At that time, he was president of the Junior Class, secretary of Student Council, chairman of the Student Council Elections Committee, chairman of the Student Council Leadership Committee, and member of Aleph Semach, junior men's honorary. The following year, besides being president of Delta Upsilon, he was a member and vice-president of Quill and Dagger, senior honorary for men, a member of the Faculty Committee on Student Conduct, and was elected to the 1952 Class Alumni Council. Walt now writes the undergraduate page in the *Cornell Alumni News*.

In keeping with his technical work here at Cornell, Walt has been with the Atomic Energy Commission during his past two summer vacations at Oak Ridge, Tennessee, and at Albuquerque, New Mexico. During his first two summer vacations he did research work for the Owens-Illinois Glass Company and the Electric Auto Light Company.

Upon graduation this June, Walt plans to continue his work in research, although he has no definite plans at the present time. It is certain, however, that whatever field he choses, his career will be a successful one.



BEYOND THE HORIZON....

Progress in reaction-motor propulsion becomes possible only as the metallurgist supplies new alloys to withstand the stresses, temperatures, and corrosive attack developed by new rocket fuels.

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TECHNIBRIEFS

A pressure fabric dyeing machine, the first major change in batch dyeing methods for fabrics in five hundred years, has recently been built by the Du Pont Company. The machine, known as Barotor, has not yet had all the refinements worked into it, but it promises to meet all the characteristics needed in an ideal dyeing machine. It is especially useful in the dyeing of new synthetic fiber fabrics, such as acrylic polyester fibers. The principle mechanical parts of the machine consist of a rotor and uniquely operating bars within a steel cylinder. Hence, the name Barotor. The machine is normally operated at two hundred and fifty degrees farenheit, corresponding to a pressure of fifteen pounds per square inch.

The fabric is at open width at all times, and is tensionless and wrinkle-free. All points are in uniform and frequent bath contact. The machine can handle batches of from one hundred to one thousand yards and needs no attention during dyeing.

Transistor Devices

Preliminary models of practical devices utilizing germanium transistors were shown by RCA in a demonstration for the press on November 17. Appraising the present status of transistor development, Dr. E. W. Engstrom, vice-president in charge of the RCA laboratories division said, "These demonstrations highlight the fact that transistors are today no longer entirely a research concern. They are, in the fields of radio and television, an immediate problem for advanced development by industry engineers who can learn how to put them to work in evolving more versatile, smaller, sturdier, and eventually lower cost equipment for industry and the public."

Since the announcement of the germanium transistor by the Bell Laboratories in 1948, much of the research work on it has been directed toward learning its fundamental theory of operation and in developing methods of controlling its operating characteristics and construction processes.

The practicability and usefulness of transistors are no longer doubtful, as shown by results of laboratory experiments. So rapid has been the development of transistors that their commerical application appears not too remote, although a considerable time may elapse before they become generally available in ample quantities and at low cost.

The transistor performs functions similar to those of electron tubes. Its characteristics are of particular interest to equipment designers who envision possibilities in its adaption to electronic circuits. It is small in size and requires extremely low power for its operation. These attributes are expected to simplify, to a large degree, the use of transistors in complex electronic equipment.

The physical ruggedness of the transistor offers other obvious advantages. In addition it requires no warm-up time and operates instantly when voltage is applied to its terminals. Moreover, the operating lives of some transistors show indications of being very long, thus minimizing replacement problems.

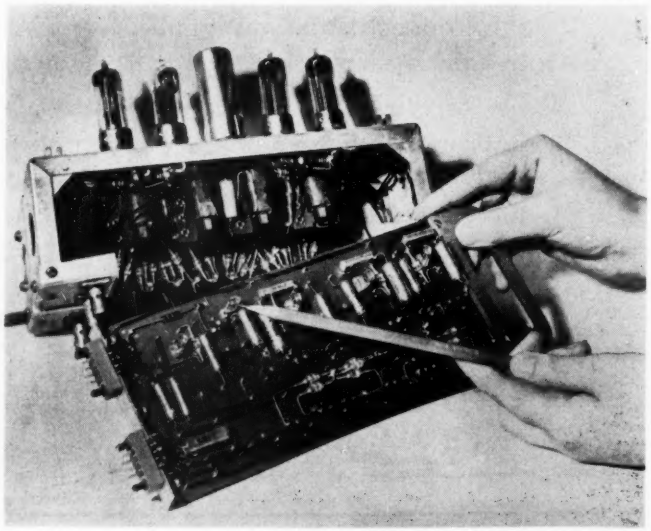
Transistors are being produced that will operate at frequencies up to a few hundred megacycles, but their power output is still relatively low. Nevertheless, when the favorable characteristics of the transistor are weighed against its limitations, this device, even in its present development stage, appears to be destined for many applications. As its characteristics are improved, new and expanding fields will be found for its use.

At this time, there are two kinds of transistors of major interest, the point-contact type and the junction type. The point-contact transistor was developed first. While it has performed at higher frequencies, the junction transistor promises to be more important than the point-contact type in many applications. Also, the junction types have lower noise, higher power gain, greater efficiency, and higher power-handling capabilities. At present these characteristics indicate that the junction transistor will be widely used in audio and radio amplifiers.

(*Continued on Page* 38)

Above, the adder with electron tubes which is equivalent to the transistor adder at bottom.

—R. C. A.



Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

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The Sign of Value Around the World

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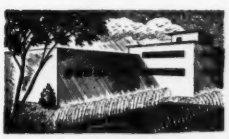


Good Water and Sanitation—engines pumps • water treatment • comminutors air compressors • air tools

Lower-Cost Manufacturing—pumps compressors • steam turbines • motors power transmission • air conditioning

Petroleum Products—compressors engines • pumps • chilling equipment refrigeration • decoking systems

More Abundant Food—compressors fertilizer mixers • air conditioning refrigeration • pumps

Technibriefs

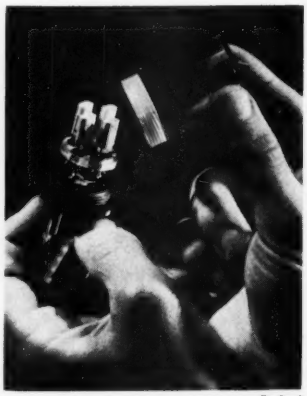
(*Continued from Page* 36)

The junction transistor is able to operate with power inputs around a millionth of a watt. For very-high-frequency circuits the point-contact transistor is superior.

Following are some of the items included in the RCA demonstration:

Portable public address system. In exploring the capabilities of transistors in audio amplifiers, a portable public address system with self-contained battery supply, instantaneous warm-up, and relatively light weight has been constructed. This experimental amplifier delivers 1.4 watts to a 12-inch speaker and operates off a 22½-volt battery supply with an estimated life of 25-50 hours. The amplifier uses six developmental and experimental junction transistors. Smaller dimensions than those of the amplifier demonstrated (18 x 13½ x 9½ inches) would be feasible, if a smaller speaker and battery supply were used.

Transistor automobile radio. This experimental receiver employs eleven developmental and experimental junction transistors to provide an audio output comparable to that of present-day automobile radio receivers. It has been designed with push-button tuning.



—*R. C. A.*

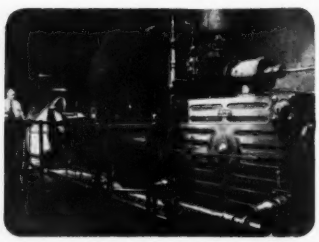
Power amplifier which uses a transistor.

An important feature of this all-transistor set is the elimination of the high-voltage power supply common to present auto receivers. This power supply, comprising a vibrator, transformer and rectifier, which are a substantial fraction of the total cost of the set, is not necessary in a transistor receiver since the transistors operate directly off the six-volt automobile battery.

Transformerless power amplifier. An entirely new kind of power amplifier assembly consists in one of its experimental forms of nothing but four developmental and experimental junction transistors mounted on a small tube socket. (see cut). The transistors used in this experimental circuit are pairs of p-n-p and n-p-n transistors in tandem operation, utilizing a unique transistor characteristic known as complementary symmetry. For many audio applications in radio, television and other sound reproduction equipment it appears that such a device can do the job that now requires two or more tubes, a phase inverter, an output transformer,

(*Continued on Page* 40)

Demonstrating the Dependability of FRICK Equipment



The portable steam engine shown at left was operated in Virginia from 1872 to 1949: the Corliss type above, built in 1891, is still running at Irwin, Penna. Another Frick Corliss, shipped in 1888, is still going strong at Weldon, N. C.

Frick Company was established a century ago for making engines and farm machinery. For over 70 years it has pioneered in building refrigerating and air conditioning systems. Frick compressors commonly achieve service records of 40 years; many have run 50; some even 60!

This portable engine still runs after 72 years' active service.

The whole story of Frick equipment is told, with 200 illustrations, in the Centennial History just published: send $1 for your copy.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

The largest Frick refrigerating machine ever built (1896), was 50 ft. long; in service for Armour 40 years.

FRICK CO. WAYNESBORO, PENNA. U.S.A.

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Hand-made, hand-painted Chinaware $1.00 up

Drinking Glasses with Cornell Seal Packed in dozens .....$4.50 up

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Animals of all kinds—from Dogs —to Zebras .....from 2.00

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Say it with Cornell Seal Jewelry—The lasting gift — Your choice of bracelets, compacts, lockets, pins, or what-have you.

May we suggest you shop early. We will gift wrap and lay aside for you.

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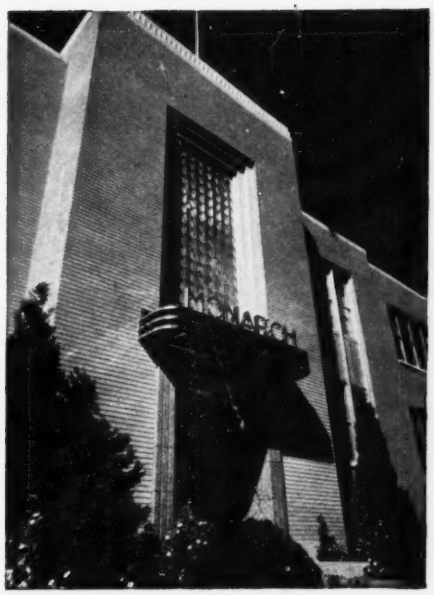
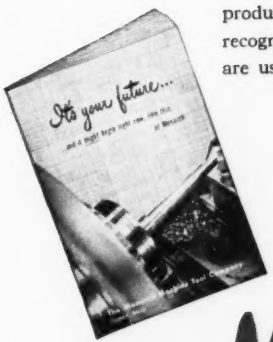


After Graduation— What?

An opportunity exists here at The Monarch Machine Tool Company for several exceptionally well-qualified mechanical, electrical and hydraulic engineering graduates of your class. Mightn't one of these men be you?

The vigorous and vital machine tool industry — keystone of our country's productive power — offers a special satisfaction to its engineers. This is due partly to the basic, sweeping impact of our industry's products; partly because of its continuing program of product development. Inquiry will show you that this is especially true at Monarch, where we specialize in designing and building lathes with a world-wide reputation — with special emphasis on Tracer Control systems for improving accuracy and rate of output.

We are in the upper bracket of our industry in size — in the top bracket in product reputation and thus in healthy growth. Engineering talent receives full recognition here. Engineering achievement here makes itself felt wherever lathes are used.



WRITE FOR YOUR FREE COPY OF THIS BOOK!

As we have said, our constant growth means that there will be several openings at Monarch for qualified members of your class. We've prepared this illustrated booklet to give you the Monarch story in more detail than we can do it here. Send for your free copy now. Just address your request to Mr. Kermit Kuck, Vice President — Engineering . . . *The Monarch Machine Tool Company, Sidney, Ohio.*

Monarch
ACCURACY • ECONOMY • LONG LIFE
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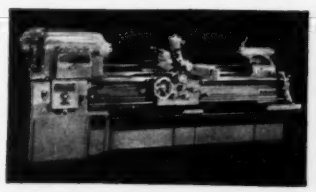

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From the Following Materials:—

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LAVA CRUCIBLE-REFRACTORIES CO.
PITTSBURGH, PA.

Technibriefs

(*Continued from Page* 38)

and other components to amplify audio signals into a loudspeaker.

Transistor counter. The application of transistors to electronic computers in which thousands of electron tubes are now used has been anticipated for some time because of the transistor's promise of smaller size, lower power, less heating, and eventually lower cost. The electronic counter is a standard element of many computers and radioactivity measuring devices. An experimental transistor counter, which utilizes 66 developmental point-contact transistors, is capable of a million individual counting actions per second. The transistor counter requires 2 watts power while a counter doing the same job with tubes would consume 60 watts.

Transistor adder. Another important element of a computer is the electronic adder (see cut). The pencil points to one of five developmental point-contact transistors in this experimental adder making possible 100,000 additions per second. The transistors do the job of four tubes and four transformers. The transistor adder requires one-quarter the power, and enables a unit one-seventh the size and one-fifth the weight of a comparable unit using tubes shown in the background.

Portable television receiver. A battery-operated television receiver using transistors to supplant all but the picture tube of a standard set has produced a satisfactory picture on its five-inch screen. Weighing 27 pounds, the unit is a single-channel receiver. It has 37 transistors, both junction and point-contact.

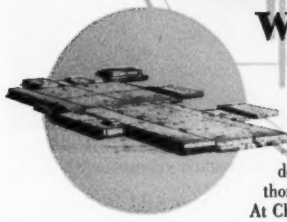
Wheat Weevil Detector

Newest "criminal" to fall victim to scientific detection methods is the lowly but destructive wheat weevil now being tracked by X-ray's penetrating eye. The bug, which sometimes resides inside a grain of wheat, has been brought out into the open by Westinghouse Electric Corporation's development of a new grain inspection X-ray unit called GIXU.

"The machine offers a rapid method of insuring that wheat meets Food and Drug Administration standards," said Walter R. Hampe, X-ray specialist, who supervised delevopment of the unit.

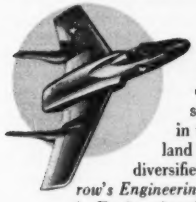
Mr. Hampe said that GIXU can complete a test in approximately 15 minutes. In making the test about a handful of wheat—a carload is judged on the insect content of a mere 100 grams—is placed in a tray and radiographed. After developing, the picture is read for the telltale black surface specks that result from newly-laid weevil eggs. If the eggs have hatched and the larva has burrowed inside the shell, the tunnel and body are easily detected by the different shadings of the wheat grain. GIXU permits the inspector to see the entire development of the weevil from egg to adult. A carload of wheat is rejected as unfit for human consumption if more than a small established minimum of insects is detected.

Greater Opportunity for the *Creative Engineer* with Chance Vought



Never before in the history of the aircraft industry has there been greater opportunity and greater demand for the young engineer with thorough training and creative ability. At Chance Vought you can join an engineering staff in one of the largest plants designed for the manufacture of military aircraft. Centered in the second largest aircraft production area in the U. S., this modern air conditioned plant is especially designed and equipped with adequate facilities for aircraft research, development and integrated production.

Security restrictions prevent a full discussion of the guided missile projects at Chance Vought, but growing requirements in all phases of development and production are creating new demands for all types of engineers and scientists. These missiles are in production for intensive experimental uses and presently are being flight tested with excellent results.



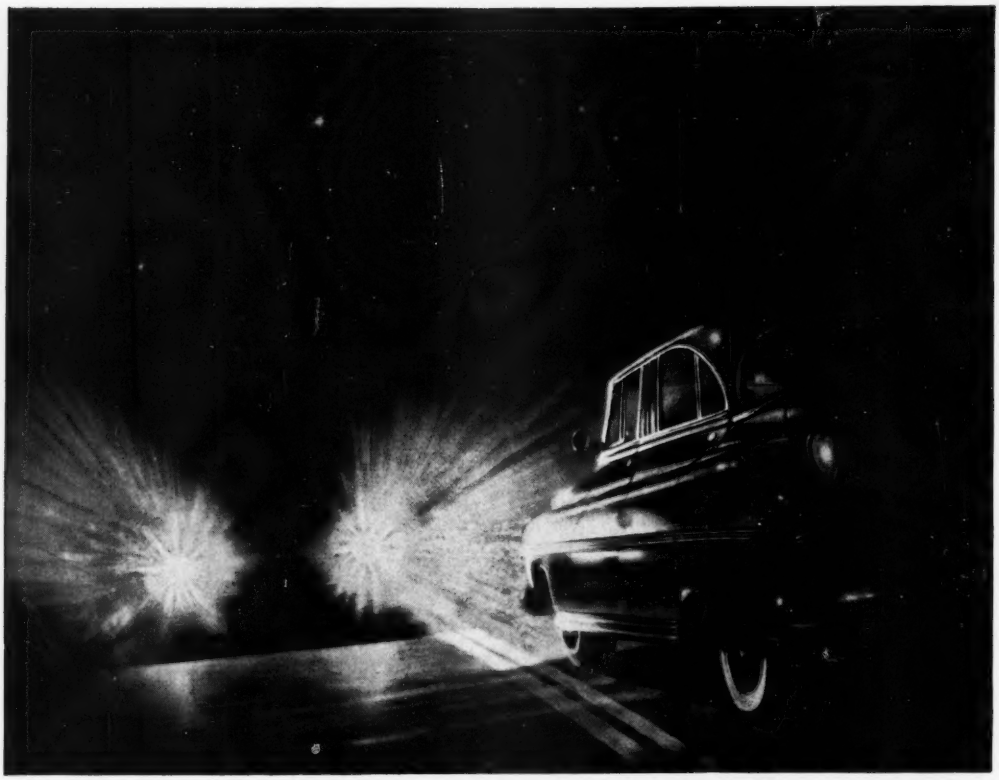
For thirty-five years Chance Vought's position in the aircraft industry has been one of pioneering and leadership. One of the latest achievements is the tailless swept wing F7U-3 "Cutlass" now in full scale production. This twin jet fighter, in the "more than 650 miles per hour category," is designed to operate from both land bases and aircraft carriers. For further information about Chance Vought and its diversified opportunities in engineering, consult a copy of our publication titled "*Tomorrow's Engineering*" now on file in your college placement library. If you are receiving a degree in Engineering, Mathematics or Physics, contact your Placement Director for an appointment with the Chance Vought Aircraft representative who will visit your campus soon.

CHANCE VOUGHT AIRCRAFT

CHANCE VOUGHT

Dallas, Texas

DIVISION OF UNITED AIRCRAFT CORPORATION



Using an electron tube developed by RCA, automotive engineers have perfected an instrument which automatically controls automobile headlights.

Out of the stars – a cure for headlight glare!

When RCA scientists developed an electron tube so sensitive that it could respond to flickering starlight, astronomers promptly put it to work in their studies of the Universe.

Called a *multiplier phototube*, RCA's invention now "takes to the road" in an instrument which will add to your safety when driving at night. The multiplier phototube is now being used in an *automatic control for automobile headlights.*

Here's how it works. RCA's tube, in a new system, sits behind your windshield where it can "see" approaching headlights. A car comes, and the multiplier phototube activates a system which shifts your headlights to low beam—returns them to high when the other car has passed. It's simple. It's completely automatic. And what's most important, it lets you keep your undivided attention where it belongs . . . *on driving your car.*

Development of the multiplier phototube is another example of how RCA research benefits you. RCA research assures you finer performance from any product or service of RCA and RCA Victor.

* * *

See the latest in radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

RCA® RADIO CORPORATION OF AMERICA

World leader in radio—first in television

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

Leonard was faced with your kind of decision!

Meet Leonard Harris and read his story. In many respects, the problems he had may parallel yours today. He made his decision six years ago, and he's glad he did.

Leonard Harris graduated from Ohio State University in 1943 with a degree in Chemical Engineering. After serving in the armed forces, he began looking into the organizations that offered promising civilian careers. And although he had many attractive offers, he chose Columbia-Southern because it gave him the opportunity to start training immediately in the field for which he felt most qualified. In his case, that field was plant operation.

Harris says, "I recalled the instructors in school had a high regard for Columbia-Southern. I knew the parent company, Pittsburgh Plate Glass, and was favorably impressed with it. Also, I was quite impressed with the sincere, down-to-earth attitude of the people with whom I made my initial contact and I wasn't disappointed on that score after joining the company."

Today, Leonard Harris is an important part of Columbia-Southern's management team. As superintendent of the Chlorine Area in the Barberton Plant the following departments come under his direct supervision: Chlorine, Caustic Soda, Pittchlor, Sodium Hypochlorite, Perchlorethylene.

Harris feels that a technical graduate should look for the following (1) a company in which he can produce and get real satisfaction from his work, (2) a company where opportunities are obvious, and (3) a company which shows no trace of employee stagnancy.

Columbia-Southern is such a company. We will be glad to discuss your interests. This pertains to graduates in all business and technical fields including engineering, research and development, sales, plant design, mining, construction, maintenance, production, accounting, transportation and related fields.

For further information, write now to our Pittsburgh address or any of the plants.

COLUMBIA-SOUTHERN
CHEMICAL CORPORATION
SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
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CASE HISTORY
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AT YOUR SERVICE

Scholarships

The American Brakeshoe Company recently announced the establishment of three $800 scholarships to be awarded annually to qualifying upperclassmen in the School of Chemical and Mechanical Engineering. The scholarships are renewable for more than one year; each $800 grant will be matched by a contribution of the same amount to the University's general operating fund.

A full-tuition scholarship of $820 a year for the study of mechanical engineering at Cornell University has been established by Mrs. Anna Jessel-Whyte of Kenosha, Wis., in memory of her son, Jessel Stuart Whyte.

Mr. Whyte, who died on May 28, received a mechanical engineering degree at Cornell in 1913. At his death he was president of the Cornell Alumni Fund Council. He had been class representative for the fund for many years.

The scholarship will be given to a freshman entering Sibley School of Mechanical Engineering at Cornell, as selected by the school's scholarship committee. He may keep the scholarship for the entire five-year course if his grades are satisfactory.

Among applicants of equal qualifications, preference will be given to those from Wisconsin, Illinois, Minnesota, Iowa and Michigan.

A program of college scholarships for Western Union employees and their children has been announced by the telegraph company. The first awards will be made to students entering college in September, 1953.

One full tuition and board scholarship, worth up to $8,000, will be provided for a four- or five-year undergraduate course at Cornell University. Two alternate tuition scholarships, each worth up to $2,500, may be used at any college or university selected by the winners.

The Cornell scholarship honors Ezra Cornell, founder of Cornell University, who built the first telegraph line for Samuel F. B. Morse and gave Western Union its name.

Western Union employees and their sons and daughters are eligible provided the employee has an adjusted company service of five years or more and earns less than $8,000 a year. The student must be a high school graduate who has not previously attended college.

Cornell University will select all winners on the basis of character, personality, capacity for academic achievement, and promise of effective participation and leadership in extra-curricular activities.

The Cornell award will be restricted to study in electrical engi-

(*Continued on Page* 48)

WE WANT TO BUY BOOKS!

We need the used books that you no longer need and we're going all out to get them.

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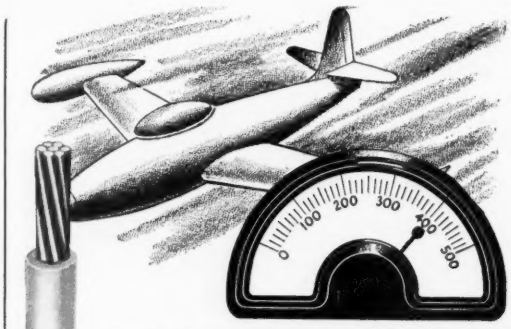
4. WE BUY BOOKS AT THE BOOK DEPARTMENT IN THE MAIN STORE AND ALSO AT THE BOOKATERIA IN THE LOUNGE SHOP AFTER IT OPENS ON FEBRUARY 6TH.

Two buying centers—No delays—Best Prices—Convenient—What more can we do!

THE CORNELL CAMPUS STORE

Barnes Hall



In the development of a new jet engine, difficulty was encountered due to the intense heats. Since the engine generated temperatures as high as 400°F., even usual heat-resistant insulations on the ignition wires would not stand up.

Okonite researchers were consulted on the problem. Their investigations led them to recommend Okotherm, an insulation of remarkable heat-resisting qualities, made by Okonite. Okotherm retains its dielectric strength over an extremely wide range of temperatures, and was consequently the first electrical cable to gain approval for the new engine.

● ● ●

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

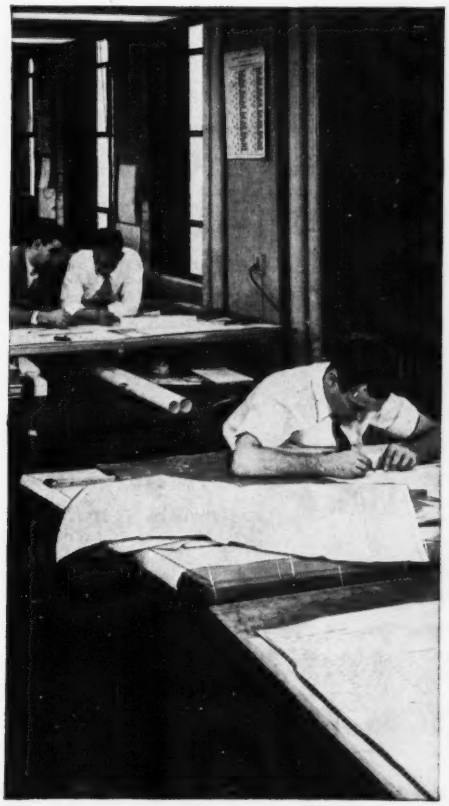
8788

Board and room to grow!

"Sure. I realize there are opportunities at General Motors. But how long will I be stuck on a drafting board before I can take advantage of them?"

This is a very familiar question to our College Representatives at their job conferences with engineering seniors.

And—in the individual case—frankly it's a hard question to answer. For often first jobs for graduates in certain phases of engineering work are at a drafting board. And the length of time the individual stays at a drafting board depends on many variables—most important being the individual's own talents and his ability to develop them.



But there is one general answer that can be made. And it's a very recent one. At a large gathering of General Motors engineers—many of them in top management—others in important divisional positions—this question was asked:

"How many of you started your GM careers on a drafting board?" The answer: practically everyone said "I did!"

So perhaps the best reply to your query about the duration of your drafting board experience is to say — "there are drafting boards and drafting boards." And a GM drafting board has this advantage—it can lead to a secure and satisfying life work in a company headed, in many cases, by engineers and with a record of supplying engineers with the equipment and the associations and the opportunities they ask to make the most of their particular training.

May we suggest you ask any such questions of our College Representative. Your College Placement Office can arrange a meeting with him on his next visit to your campus. Or drop us a line.

GM POSITIONS NOW AVAILABLE IN THESE FIELDS:

Mechanical Engineering
Electrical Engineering
Metallurgical Engineering
Industrial Engineering
Chemical Engineering

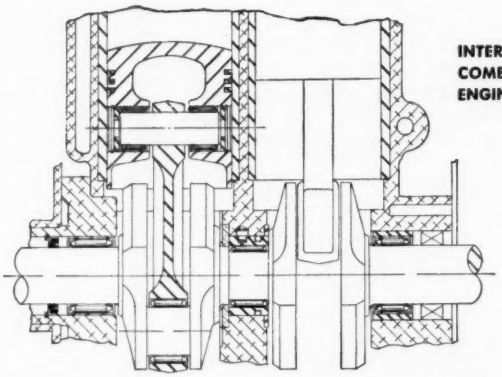
GENERAL MOTORS

Personnel Staff
Detroit 2, Michigan

The Torrington Needle Bearing...

for designs where light weight is important

Reducing weight without sacrificing performance is one of the major considerations in many modern products. Designs are streamlined to pare off excess weight. New and lighter materials are being used. Components which save even a few ounces frequently contribute greatly to product success.



Needle Bearings reduce weight and size while providing high radial load capacity.

Light Weight Plus High Capacity

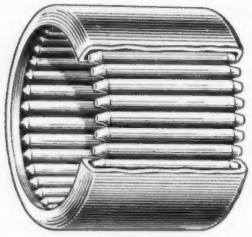
The unique design of the Torrington Needle Bearing makes it ideal for a wide variety of product uses. It consists of two components – a thin, hardened outer shell and a full complement of small diameter rollers. Its many lines of contact give the Needle Bearing a greater rated radial load capacity than any other type of anti-friction bearing for its size and weight. Conversely, for a given load capacity, a Needle Bearing is the lightest, most compact bearing available.

Weight Savings In Related Assemblies

In addition to the light weight of the Needle Bearing, its design permits sizable reductions in the size and weight of the related assemblies. Its small outside diameter allows the use of smaller housings. And, since a press fit in a simple straight housing bore is adequate to locate the bearing, no complex shoulders or housing modifications are required. The hardened shaft usually serves as the inner race, saving additional space and weight.

These advantages, plus its high radial capacity, have made the Torrington Needle Bearing particularly attractive to the designers of aircraft, portable power tools, small gasoline engines and many other products where weight and space are important factors.

In future advertisements of this series, other features of Torrington Needle Bearings will be discussed. The new Needle Bearing catalog will be sent on request.



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Torrington, Conn. • South Bend 21, Ind.

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TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

Graduate Engineers!

ENJOY GOOD SALARY FROM THE FIRST DAY... INTERESTING CHALLENGES RIGHT AWAY!

At Sperry you can apply your knowledge immediately and keep on learning—with pay—in research, product development, or field work. Salary increases come as you progress.

You enjoy the advantages of working with the leaders in their fields. You are expected to use originality and a fresh approach. Every project is a creative challenge to the brain-work and the team-work of the Sperry engineering staff.

VARIETY OF OPENINGS

There are opportunities for aeronautical, electrical, electronic, mechanical engineers – physicists – technical writers and field engineers for applied engineering.

ATTRACTIVE LOCATIONS GOOD WORKING CONDITIONS

Long Island—In pleasant suburban atmosphere but convenient to New York. Modern plant. Well equipped laboratories. Excellent working facilities.

In the Field—There are excellent applied engineering opportunities in various sections of the United States and abroad.

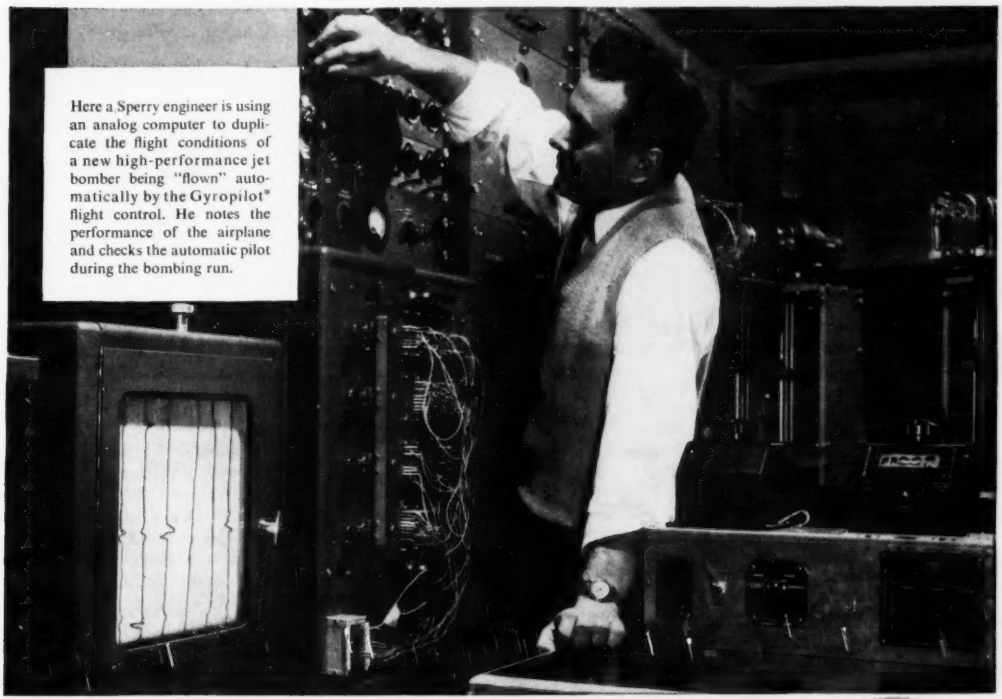
In All Locations—The way is clear for steady advancement. You are encouraged to continue your education while you earn. And liberal employee benefits are provided for all.

RESEARCH LEADERSHIP... A FORTY-YEAR TRADITION

Today Sperry is the recognized leader in developing automatic controls for navigation. From Sperry's work in gyroscopics and electronics have come the Gyropilot* flight controller, Zero Reader* flight director, radar, servomechanisms, computing mechanisms and communications equipment.

Sperry sponsored the development of the klystron tube—the first practical source of microwave energy. From Sperry pioneering has come a complete line of Microline* instruments for precision measurement in the entire microwave field.

CHECK YOUR PLACEMENT OFFICE FOR DATES WHEN SPERRY REPRESENTATIVES WILL VISIT YOUR SCHOOL...OR WRITE SPERRY EMPLOYMENT SECTION 1A5.



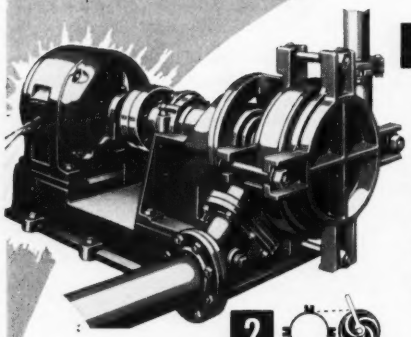
Here a Sperry engineer is using an analog computer to duplicate the flight conditions of a new high-performance jet bomber being "flown" automatically by the Gyropilot* flight control. He notes the performance of the airplane and checks the automatic pilot during the bombing run.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION

*T. M. REG. U. S. PAT. OFF.

GREAT NECK, NEW YORK · CLEVELAND · NEW ORLEANS · BROOKLYN · LOS ANGELES · SAN FRANCISCO · SEATTLE
IN CANADA – SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

Morris
Type R Slurry Pump
Gives Longer Service, Less Trouble
because



1

No internal studs or bolts — no troublesome internal joints and fits. Suction Disc Liner is merely *clamped* into position between disc and shell. Fewer wearing parts mean less maintenance and longer uninterrupted service.

2

Impeller and shaft sleeve of the Morris Type-R Slurry Pump can be renewed *without disturbing* the suction and discharge piping or the bearings. This means considerably less lay-up time.

3

Due to the clamping effect of the bolts on the discs, the shell is not subject to high stress. Consequently, the shell can be made of a wide variety of materials, including those of high abrasive resistance. Yet these materials need not necessarily be of high tensile strength.

4

Hydraulic passages of the suction discs are extremely large and velocities are low. As a result, wear is minimized and renewal infrequent.

5

FREQUENT PACKING + SHAFT SLEEVE RENEWAL

Stuffing box troubles are practically eliminated because the suction gland is under low suction pressure only.

Write today for free bulletin

Practical information in Bulletin No. 181 shows by performance curves just how the Morris Type-R Slurry Pump fits specific operations . . . describes exclusive construction features that cut operating costs.

FOR CHEMICAL OPERATIONS
Morris Type-R Slurry Pump handles mixtures containing ore concentrates . . . tailings, slag and residue from filters and classifiers . . . all types of caustic or acid mixtures containing abrasives or solids.

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MORRIS *Centrifugal Pumps*

Service

(*Continued from Page 44*)

neering, mechanical engineering, civil engineering, chemical engineering, engineering physics, industrial and labor relations, business administration or arts and sciences. The other scholarships may be applied in any field.

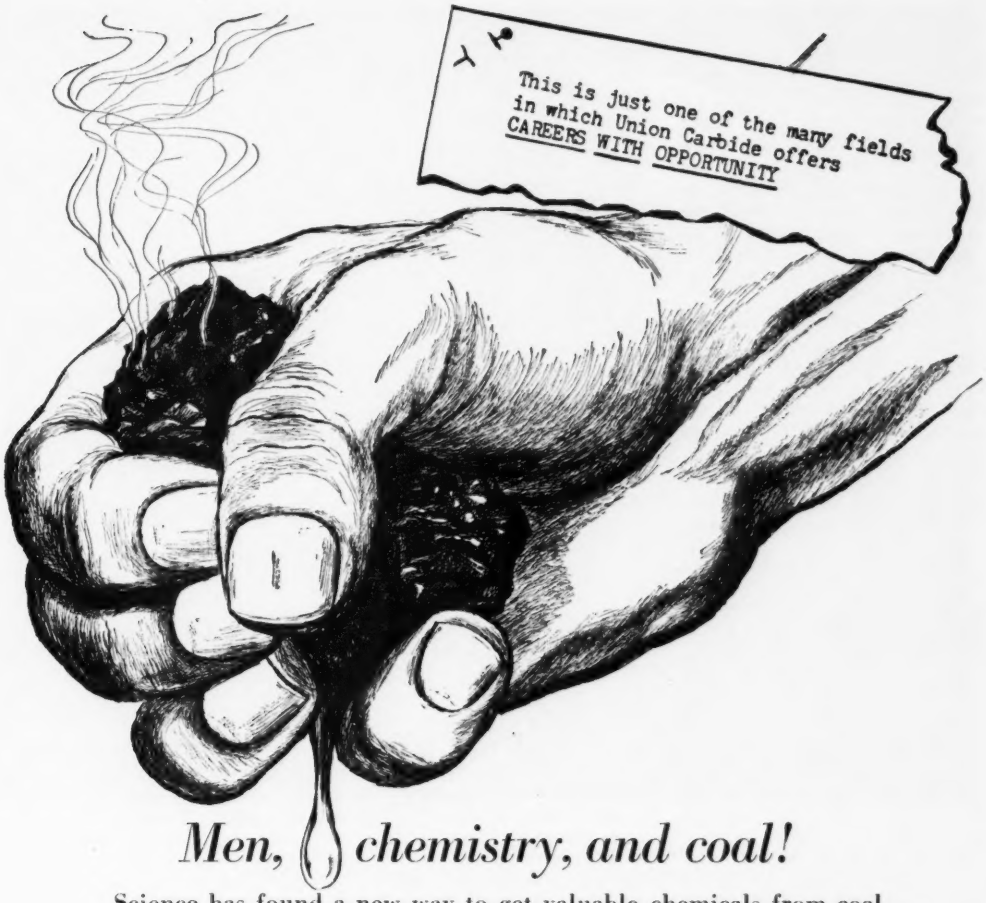
Better Roads Awards

As a nation we are not building or improving highways as fast as our dependency upon motor transportation is increasing. The result is a nationwide traffic snarl that costs the public untold millions in lost time and causes needless accidents every day.

To encourage all Americans to think about this critical situation and come forward with practical solutions, General Motors is instituting the GM Better Highway Awards for the best essays submitted on the following subject: "How to Plan and Pay for the Safe and Adequate Highways We Need." A total of 162 State, Regional and National Awards will be given for those entries which are considered best by an independent board of five judges, to include the president of the National Safety Council, head of the U. S. Commerce Department's Bureau of Public Roads, and the president of the University of California.

To be eligible for award consideration, each essay must be submitted with an official entry blank which may be secured by asking any General Motors car or truck dealer or by writing to General Motors, Better Highway Awards, General Motors Building, Detroit 2, Michigan. A contest entry must be postmarked not later than midnight, March 1, 1953, and must be received by March 14, 1953.

No limitation is placed on the length of the essay, which will be judged for originality, sincerity, and practical adaptability. Awards include first, second, and third national prizes of $25,000, $10,000, and $5,000, with three honorable mention awards of $3,000 each. Nine regional awards, each $2,500, and 147 state awards will be made.



Men, , chemistry, and coal!

Science has found a new way to get valuable chemicals from coal

Science has at last found a practical way to convert coal into the host of valuable chemicals that nature locked into it.

The people of Union Carbide have developed a way to bring coal and hydrogen gas together under carefully controlled heat and pressure. In minutes, this revolutionary process—called *coal hydrogenation*—converts the coal into a mixture of gases and liquids that are rich in useful chemicals.

A WEALTH OF RAW MATERIALS—Among them are hitherto scarce, and even completely new, chemicals. Some are raw materials for plastics and synthetic rubber, or are vital to medicine and vitamins. Some are valuable in rocket propulsion. Others are necessary in insecticides, surface coatings, and many other important uses.

A NEW SOURCE OF SUPPLY—Today, Union Carbide's coal-hydrogenation process promises steady and vastly increased production of chemicals for these needed materials. What's more, it will provide a host of chemicals that may become the basis of many new products.

A UCC ACHIEVEMENT—With the first coal-to-chemicals plant of its kind in operation, the people of Union Carbide are now well on the way to making abundant coal a source of chemicals important to us all.

STUDENTS and STUDENT ADVISERS

Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS. *Ask for booklet A-1.*

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UCC's Trade-marked Products of Alloys, Carbons, Chemicals, Gases, and Plastics include

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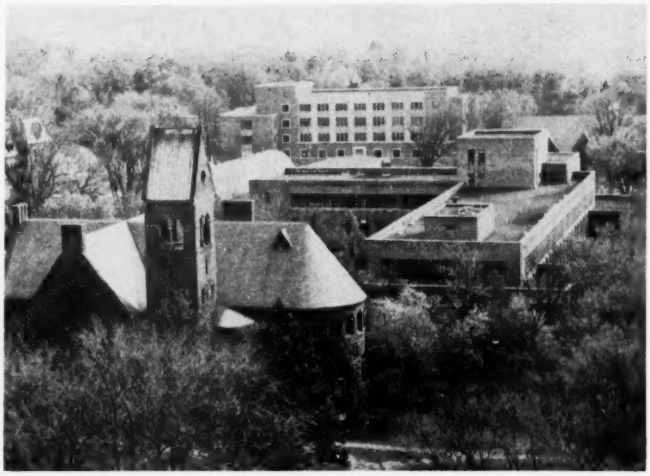
ELECTROMET Alloys and Metals • HAYNES STELLITE Alloys • PREST-O-LITE Acetylene • PYROFAX Gas
EVEREADY Flashlights and Batteries • NATIONAL Carbons • ACHESON Electrodes • PRESTONE and TREK Anti-Freezes

On November 13, 1952, at 8:00 A. M., the first class of engineering students to assemble in the new materials buildings rubbed their eyes and gazed around the bare interior of what is to be one of the United States' most modern engineering laboratories. The second step in a long-range program to integrate engineering at Cornell and to provide facilities to advance the rapid development of engineering itself was completed, and the results were inspiring.

Kimball and Thurston Halls are part of a prospective engineering campus which will be located at the south end of the University between Central Avenue and Hoy Field. The first move in this drive to re-establish the location of the engineering schools at Cornell and to provide the various schools with more advanced facilities was the construction of Olin Hall of Chemical Engineering far across the Quad from the family of engineering buildings. Completed in 1942, Olin Hall, the gift of the late Franklin W. Olin, C.E. '86, is one of the five major units which are called for by the preliminary plans of the designers. The other units will house the Schools of Mechanical, Civil, and Electrical Engineering, and the various laboratories which will serve these schools.

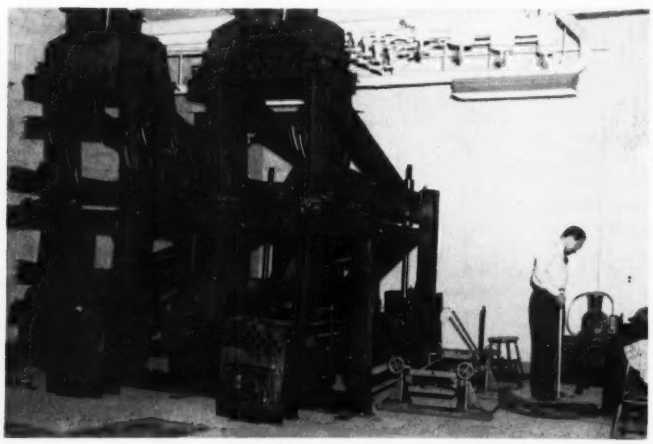


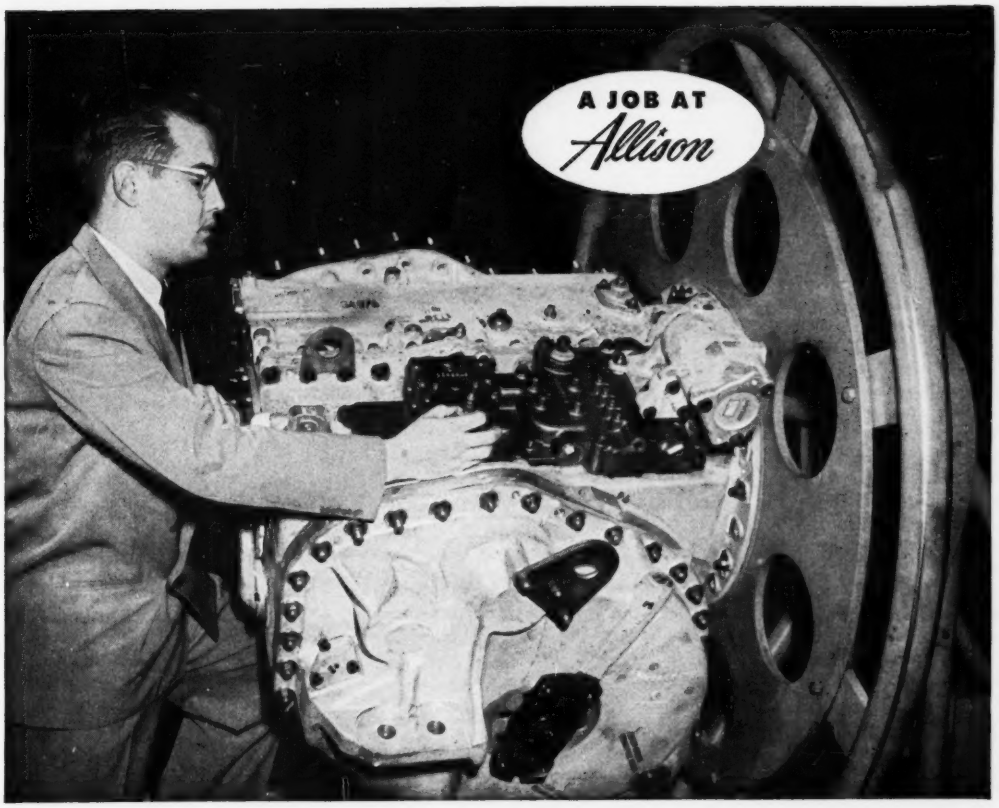
View of the new materials laboratory with Barnes and Olin Halls in the foreground.

Kimball and Thurston Halls Nearly Completed

Specifically, Kimball Hall is the Materials Processing Laboratory and as such, will concern itself chiefly with the condition of metal as it goes through different machining processes, and the relative advantages of using these processes for a particular desired result. It will contain, when fully equipped, a large machine tool and production laboratory, which will supplant Rand Hall machine shop, and many smaller laboratories such as the wood laboratory, gauge laboratory, and constant temperature room. Ample provision has of course been made for offices, class rooms, and lecture and demonstration rooms. The laboratory will be used for undergraduate instruction and for testing and research, which will be carried out by the advanced students and staff members. It is certainly a fitting tribute to the man who gave much to engineering, and to whom engineering meant so much, that this building reflects his life's work so adequately. Professor Dexter S. Kimball's career was ended just a short time ago, but the spirit of progress in engineering which he exemplified remains as firmly rooted as this structure which bears his name.

Beam-bending apparatus in Kimball-Thurston Hall laboratory.





● Robert F. Karcher, a 1951 Mechanical Engineering graduate from Purdue University, is another Allison engineer who is pioneering in an advanced field of mechanics. He is playing an important role in the Research and Development group of the Transmission Engineering Section.

Allison is the world's largest manufacturer of torqmatic drives for heavy-duty Ordnance and commercial vehicles and equipment. These transmissions serve a purpose far broader than a unit in the power train. All the steering and braking of the vehicle also are accomplished in the transmission. These operations are controlled by hydraulic circuits which consist of clutches, pumps, governors and necessary valving to make them operate in the proper sequence. The assembly of the valving system is often termed the "brain box" of the transmission since it determines how the transmission will operate to provide maximum performance and maneuverability with finger-tip control.

Bob, shown above examining a CD-500 transmission, is involved in developing a new improved system of governing automatic control systems of many Ordnance and commercial transmissions. This involves basic analysis, design and testing of pilot samples. These hydraulic controls provide proper sequence for clutch operation to determine speed range, convertor or lock-up operation. They also provide steering control for the vehicle when this function is included in the transmission.

Bob and other Allison engineers are continually applying their knowledge, experience and imagination to find successful answers in the never-ending search for product improvement. There is a real engineering challenge at Allison and lifetime opportunities for engineers.

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The companion building to Kimball Hall is Thurston Hall, a materials laboratory designed to afford a complete range of testing and research methods under general and specific conditions. Its laboratories have many special features which make possible the synthesis of conditions that ordinarily could not be reproduced on a university campus. The vibration-free room, dynamic photoelastic laboratory, heat treating room, and many individual research laboratories, when completely equipped and staffed, will be a major improvement in the field of materials and structures. Of particular interest is the structure testing wing which will enable full scale tests of a complete structure to be made. This wing is about fifty feet high and contains anchorages and buttresses which will permit loading at any point from any direction; it is supported by four 10 ton steel columns. The building itself contains 7800 tons of structural steel and 4000 cubic yards of concrete. Indications seem to be that the major part of Thurston Hall will be used for research work, but the facilities will be available for undergraduate instruction to supplement the work carried on in Kimball Hall.

Work on the new laboratory nears completion.

The building was named in honor of Dr. Robert Henry Thurston who came to Cornell in 1885 as head of the Sibley College of Engineering and for eighteen years guided the college through a period of rapid growth and development.

The plans of the designers call for three additional wings to be connected to Kimball and Thurston Halls. One of these will be a foundry, and the others will be an applied metallurgy laboratory and a non-metallic materials lab. With construction underway on Teagle Hall, a new gymnasium to replace the Old Armory, it may not be too long before work is begun on these other sections in the development program, which are to be located on the present site of the Old Armory. The new school of Electrical Engineering is also in the final planning stages and no doubt many people are anxious to see work begun on that structure.

It is fortunate indeed that there are those who have the desire to see university engineering progress abreast of industrial engineering, and who realize the necessity for expansion in Cornell's Engineering College. As Kimball and Thurston Halls become part of this expansion, Cornellians may point with pride at the results and look confidently to the future.

● For many years K&E has pioneered in the manufacture and development of finest quality surveying instruments. K&E surveying instruments are renowned all over the world for their superb performance under conditions of all kinds, for their magnificent workmanship and for special features that come of progressive ingenuity.

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THE DU PONT DIGEST

THE TECHNICAL MAN IN

Production Supervision

Scientists who know both people and processes are needed to keep Du Pont's 71 plants humming

H. D. Tallman, *B. S. in Industrial Administration, Yale '37, checks on product loading methods in Du Pont's Belle, West Va., synthetic urea plant.*

Keeping production rolling in a modern industrial plant is a job that appeals to men trained in many branches of science and engineering. If you are looking for opportunities in this field, you won't have to look far at Du Pont, where nearly half the entire technical force is assigned to production supervision.

To qualify, a man must have the ability to understand both the mechanical and chemical phases of production. In addition, he should be a good planner and, above all, have a knack for handling people.

The production supervisor—there are several levels at Du Pont—has three important areas of responsibility. The first is to the men working for him. He must be able to appraise them skillfully and assign duties accordingly. He must train them not only in the efficient operation of equipment but in safe working practices as well.

A second responsibility is to the customer. He must get the product out on time and provide uniformly high quality at the lowest possible cost. When demand for a product is subject to rapid fluctuations, he must be prepared to make quick readjustments in the scheduling of both manpower and materials.

William Chelgren, *B.S. in M.E., Armour Institute of Technology '38, explains quality control methods to a group of Du Pont production supervisors.*

The supervisor's third responsibility is to the higher management. Here, again, quality and cost are important factors. He is expected to prepare forecasts, to justify unusual expenditures, and to suggest process improvements leading to greater yield and better quality at lower costs.

One of the toughest nuts a production supervisor has to crack is the scheduling of preventive maintenance for minimum interference with production. In some companies where products are turned out in small-unit operations, a program of breakdown maintenance suffices. At Du Pont, however, where large-unit operations are the rule, unscheduled downtime is costly and something to be avoided whenever possible.

Since it makes over 1200 products and product lines, Du Pont can offer to men interested in production supervision opportunities in many types of operations. In the next issue of the *Digest*, we will describe a specific production operation in one of our 71 plants.

36-PAGE BOOK, "The Du Pont Company and the College Graduate," describes opportunities for men and women with many types of scientific training. For copy, write: 2521 Nemours Building, Wilmington, Delaware.

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

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NEWS OF THE COLLEGE

Nine students in the School of Chemical and Metallurgical Engineering have received Foundry Educational Foundation scholarships for the coming year.

The foundation's scholarship program aims to interest young men in studying foundry science and to encourage graduating engineers to enter the foundry industry. Cornell is one of 13 institutions participating in the program. It has received a total of $44,500 in scholarships since the program began in 1947.

Scholarship winners are: Otto P. Eberlein '54, Lakewood, Ohio; Rupert L. Ogden '53, Atlanta, Ga; Albert E. Pyott '54, Chicago, Ill.; Henry Robinson '53, Akron, Ohio; William M. Sutcliffe '56, Baltimore, Md.; William C. Thurber '55, Rome, N.Y.; Alden C. Tribe '53, Nichols, N.Y.; Roger C. Waugh '54, Pelham, N.Y.; and Marvin Zevin '53, Woodside, N.Y.

Tau Bete Tutoring

Helping freshman engineers and architects to smooth their study difficulties is a traditional service project of Tau Beta Pi, engineering honorary society. Both actives and pledges of the organization are ready to give free tutoring service to fit the needs of any student. The program has proved very successful; for the Tau Betes enjoy tutoring, and the freshmen who have used the service have found it definitely beneficial. So far this year, the Tau Betes have worked with about fifty freshmen who requested aid in calculus, physics, chemistry, and descriptive geometry. The amount and schedule of individual tutoring are perfectly flexible and are worked out between tutor and student in accordance with the desires of the student.

Any freshmen engineer who wishes to receive help in his studies may apply to Dick Drosendahl, CE '53, phone Ithaca 2009, chairman of the tutoring program. The applicant will be assigned to a Tau Beta Pi member with whom he can plan his own tutoring schedule.

Mrs. Carpenter Elected

Professor Martha Stahr Carpenter of the Cornell astronomy department has been elected to the Commission on Radioelectric Observations of the International Astronomical Union.

The commission met for the first time during the Eighth World Congress of the Union in Rome from September 4 to 13.

Mrs. Carpenter represented the Cornell Radio Astronomy Research Project, sponsored by the Office of Naval Research, at the congress. She was flown to Europe by the U.S. Navy.

Dr. Burrows Elevated

Dr. Charles R. Burrows (fellow IRE, AIEE, and Am. Phys. Soc.), director of the School of Electrical Engineering at Cornell University, has been elected vice-president of the International Scientific Radio Union for a two-year term. He was re-elected president of its Commission II on Tropospheric Propagation.

Dr. Burrows headed the U.S. delegation to the tenth general assembly of the Union in Sydney, Australia. He has been chairman of the national committee of ISRU for the past two years.

Dr. Burrows heads Cornell's Navy-supported radio astronomy project. During World War II he collaborated in the development of radar and the proximity fuse. In 1943 he undertook the organization of a committee to coordinate all research in this country on radio wave propagation. Working with a similar committee in England, the group coordinated research in England, Australia, Canada and New Zealand.

Dr. Burrows' studies in the mid-twenties on short wave propagation contributed to the development of short wave transoceanic telephone service. With rising interest in ultra-short radio waves for communications, he led a group of engineers in uncovering the basic mechanisms of wave propagation and estimating propagation conditions on all types of transmission paths.

He is a graduate of the University of Michigan and has master's and doctor's degrees from Columbia. Before coming to Cornell in 1945, he was with the Bell Telephone Laboratories.

AEC Fellowships

Extensions of their Atomic Energy Commission fellowships for this academic year have been given to four candidates for doctoral degrees in Physics. They are Gordon L. Lasher of Hensonville, Jules S. Levin of Miami Beach, Fla., Gerald K. O'Neill of Newburgh, and John W. Weil of New York City.

Three young nuclear physicists are visiting fellows at the University this year on post-doctoral fellowships from the National Science Foundation: Marvin H. Friedman, Marc Ross, and Silvan Schweber of New York City. They are working on theoretical problems under Professor Hans A. Bethe in the Newman Laboratory of Nuclear Physics.

ASCE Lecture

"European Hydraulic Laboratories" was the topic of a talk given by Professor Andre L. Jorissen of Cornell before the November meeting of the Ithaca section of the American Society of Civil Engineers. In his illustrated lecture, Professor Jorissen described ten hydraulic laboratories in Belgium,

France, Switzerland, and Italy, which he visited during the past summer. He discussed the work the laboratories are doing toward solving problems in drainage, irrigation, flood control, water supply, rivers and harbors, and in design and operation of hydraulic machinery.

Now head of the hydraulics department of the School of Civil Engineering, Professor Jorissen formerly taught at the University of Liege in Belgium, and at Penn State. In 1948 he was advisor to the Central Hydraulic Laboratory in Paris.

Course in Transistors

Science's new wonder midget, the transistor, has entered the classroom at Cornell University.

Cornell is offering one of the first college courses dealing with the pea-sized bits of electron magic, which hold promise for major advancements in television, computing and other fields.

Eighteen seniors and graduate students are taking the elective course, which began in September as a joint offering of the School of Electrical Engineering and the Department of Physics. The instructors are Prof. Clyde E. Ingalls, Prof. Robert L. Sproull, and Prof. Robert D. Wilson.

The students hear two lectures a week and spend an afternoon in the laboratory. Much of the laboratory work is devoted to experiments with the transistors themselves and with germanium, the rare metal which makes them possible.

Sample transistors are being supplied by various manufacturing firms.

The transistor, developed originally at the Bell Telephone Laboratories, has size and weight advantages over the vacuum tube, which it is expected to replace in many applications. Transistors need no warm-up period and consume less electric current than the tubes, thus opening new fields to the electronics engineer.

The transistor requires no vacuum. Its major active element is a tiny sliver of germanium.

Hiroshi Amemiya, a graduate student, and Roland O. Peterson, a fifth-year electrical engineer, measure the speed of movement of electrons and "holes" in germanium as Prof. Clyde E. Ingalls looks on.

Monsanto Scholarships

The Monsanto Chemical Company has established three full tuition scholarships for seniors at Cornell. This year's winners are Richard H. Hillsley of Larchmont, N.Y., Miss Joanne McCurdy of Wynnewood, Pa., and Robert M. Messner of Great Neck, N.Y.

The awards of $700 will go annually to a senior in the Department of Chemistry, a fifth-year student in the School of Mechanical Engineering, and a fifth-year student in the School of Chemical and Metallurgical Engineering.

The scholarship committees in the three divisions choose the winners on the basis of academic standing, personal qualifications and probable success in their careers.

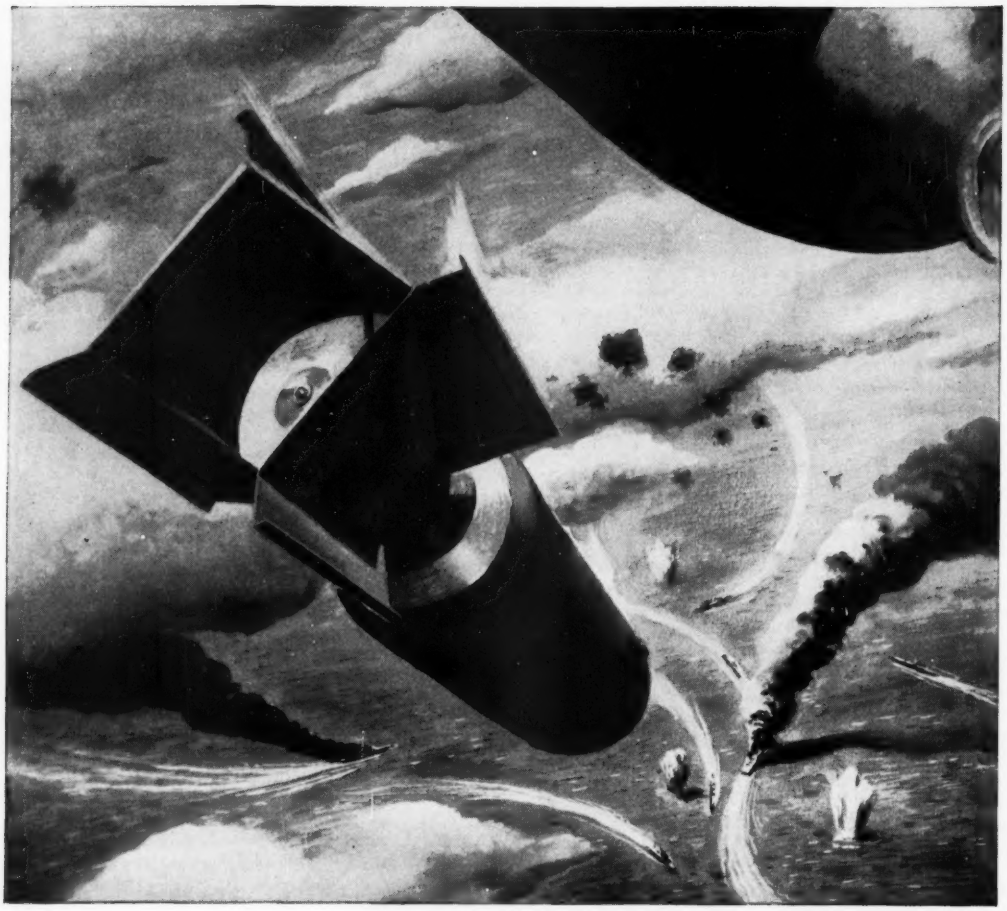
Prof. White Leaves

Professor Kendall C. White '34, Mechanical Engineering, who left the University on July 1, is now production manager of the Wico Electric Co., Springfield, Mass.

Management Club

The Industrial Management Club of Ithaca held its November meeting as guests of Cornell University's Physics Department and the Laboratory of Nuclear Studies. The club which has a membership of 200 attended a dinner at Willard Straight Hall. After the dinner a guided tour of the Laboratory of Nuclear Studies was conducted by Mrs. Roger Knox. Following this the group assembled in Rockefeller Hall where Professor G. E. Grantham gave a demonstration lecture illustrating many fundamental laws of mechanics.

The Industrial Management Club of Ithaca is a member of the National Council of Industrial Management Clubs. Its purpose is to improve supervisory relations and policies through discussion groups, lectures and training programs given by the extension series of the ILR school. As a part of this program, tours through local concerns are arranged.

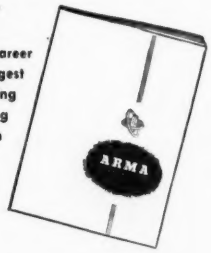


Pin-pointed for its target...

Increasing air speeds and higher level flight pose ever tougher problems for bombing accuracy. But modern engineering takes such problems in stride. Today's bombardiers pin-point targets with bombing systems of extraordinary precision and nearly instantaneous action.

Engineering and developing these and similar complex electronic or electro-mechanical devices are the work of Arma Corporation. For 34 years Arma has collaborated with the Armed Forces—and more recently the Atomic Energy Commission—on such complex instruments. Adaptations of these systems will be readily applied to our industrial might in the future. Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y.; Subsidiary of American Bosch Corporation.

If you are interested in an engineering career with challenging opportunities, we suggest you write for this booklet "Engineering at Arma." Write today to Engineering Division, Arma Corporation, 254 36th St., Brooklyn 32, N. Y.



ARMA ADVANCED ELECTRONICS FOR CONTROL

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But I haven't majored in aeronautical engineering

That doesn't matter. Lockheed can train you... at full pay!

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Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

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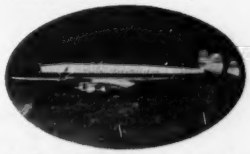
This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

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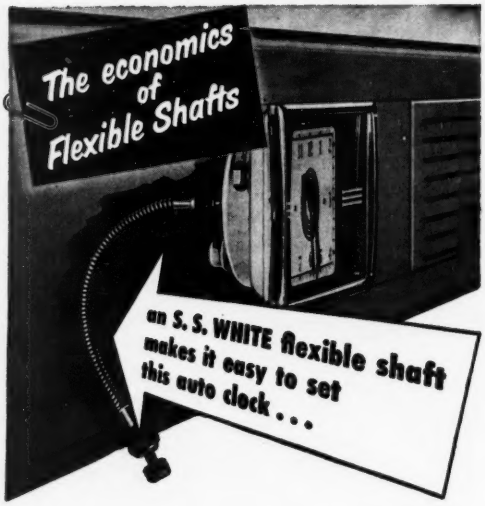
MARCH OF DIMES

FIGHT INFANTILE PARALYSIS

JANUARY 2-31



When this automobile clock was designed, its manufacturer had in mind the probability of varied instrument panel locations with the resultant need of an adaptable coupling to the control knob. He chose an S.S.White flexible shaft to do the job. As the illustration shows, this simple hook-up permits both the clock and the control knob to be located in its most advantageous position.

* * * *

Many of the problems you'll face in industry will involve the application of power drives and remote control with the emphasis on low cost. That's why it will pay you to become familiar with S.S.White flexible shafts, because these "Metal Muscles"® represent the low-cost way to transmit power and remote control.

SEND FOR THIS FREE FLEXIBLE SHAFT BOOKLET . . .

Bulletin 5008 contains basic flexible shaft data and facts and shows how to select and apply flexible shafts. Write for a copy.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. Dept. C, 10 East 40th St. NEW YORK 16, N. Y.

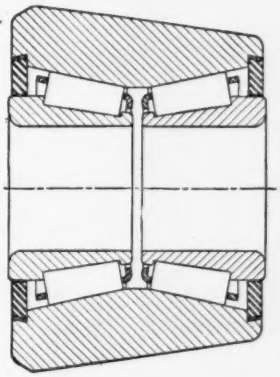
Another page for **YOUR BEARING NOTEBOOK**

Makes short work of tall timber

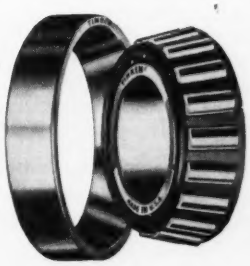
Motorized log-loaders speed their way over rough terrain to get to a cutting site. Once there, they load cut timber in a hurry, then head for the next place they're needed. To keep them on the go without costly interruptions, designers specify Timken® tapered roller bearings in the wheels, cone rollers, swing drums, steering pivot and other vital moving parts. Timken bearings have extra load-carrying capacity. They prevent wear, reduce maintenance. Assure continuous, trouble-free operation.

How to mount log-loader cone rollers on TIMKEN® bearings

This special roller bearing assembly has two single-row extended bearing cones mounted directly into the roller. The outer race of the bearing is actually the roller itself with the tapers ground to the proper angle for the bearing cone and roller assemblies. Closures are pressed into each end of the roller with running clearance at the extended cone rib.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



Want to learn more about bearings?

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. Clip this page for future reference, and for a free copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳

STRESS and STRAIN...

He asked for burning kisses,
She replied in accents cruel—
"I may be a red-hot mama,
But I ain't nobody's fuel!"

* * *

"We'll have to rehearse that," said the undertaker as the coffin fell out of the wagon.

"Attach capacitor 'A' to chassis 'B', solder lead 'C' to capacitor 'A' and resistor 'D'. . . .

A motorcyclist, in an effort to keep warmer, put his coat on backwards so that the back would better protect the chest. As he sped down the highway, a car dashed across his path from a side road, and the cyclist was thrown into a ditch. The police soon came along, and one of them attended the prostrate cyclist.

"How is he?" asked one cop.

"What a shame!" replied the other, "The poor lad had his head turned around. By the time I got it straightened out, he was dead."

* * *

The height of bad luck: seasickness and lockjaw.

* * *

Dear Pop,

Everything fine at school. I'm getting lots of sleep and am studying hard. Incidentally, I'm enclosing my fraternity bill.

Your son,
Pudge.

Dear Pudge,

Don't buy any more fraternities.

Your Pop,
Pop.

"My boy," said the business man to his son, "there are two things that are vitally necessary if you are to succeed in business."

"What are they, Dad?"

"Honesty and sagacity."

"Always, no matter what happens, no matter how adversely it may affect you, always keep your word once you have given it."

"And sagacity?"

"Never give your word."

* * *

An enemy, I know, to all
Is wicked, wicked alcohol.
The Good Book, though, commanded me
To learn to love my enemy.

There had been an accident. It was the same old thing: a student's convertible had collided with the farmer's model A. The two drivers got out and surveyed the damage. "Well," said the farmer, "we might as well have a drink." He hauled out a bottle and passed it to the student, who gulped down a stiff one. The farmer calmly returned the bottle to his pocket. "Aren't you going to have one?" asked the college student. "Don't believe I will," was the answer, "until the police have checked up."

* * *

ROTC Sergeant: "Does your uniform fit satisfactorily?"

Frosh: "Well, the jacket is okay, Sir, but the pants are a bit snug under the armpits."

Little Audry, mad as hell,
Pushed her sister in the well.
Said her mother, drawing water,
"Gee, it's hard to raise a daughter."

* * *

A man fell overboard from a Caribbean liner and screamed for help as he saw a school of man-eating sharks headed his way. A famous criminal lawyer called from the steamer, "I'll help you," and dove into the ocean. Immediately the sharks formed a two-lane escort, and convoyed the two men back to the ship. "It's a miracle," cried the rescued man. "Not at all," said the lawyer, "merely professional courtesy."

* * *

Not so long ago, a disheveled EE walked into a psychiatrist's office, tore open a cigarette, and stuffed tobacco up his nose.

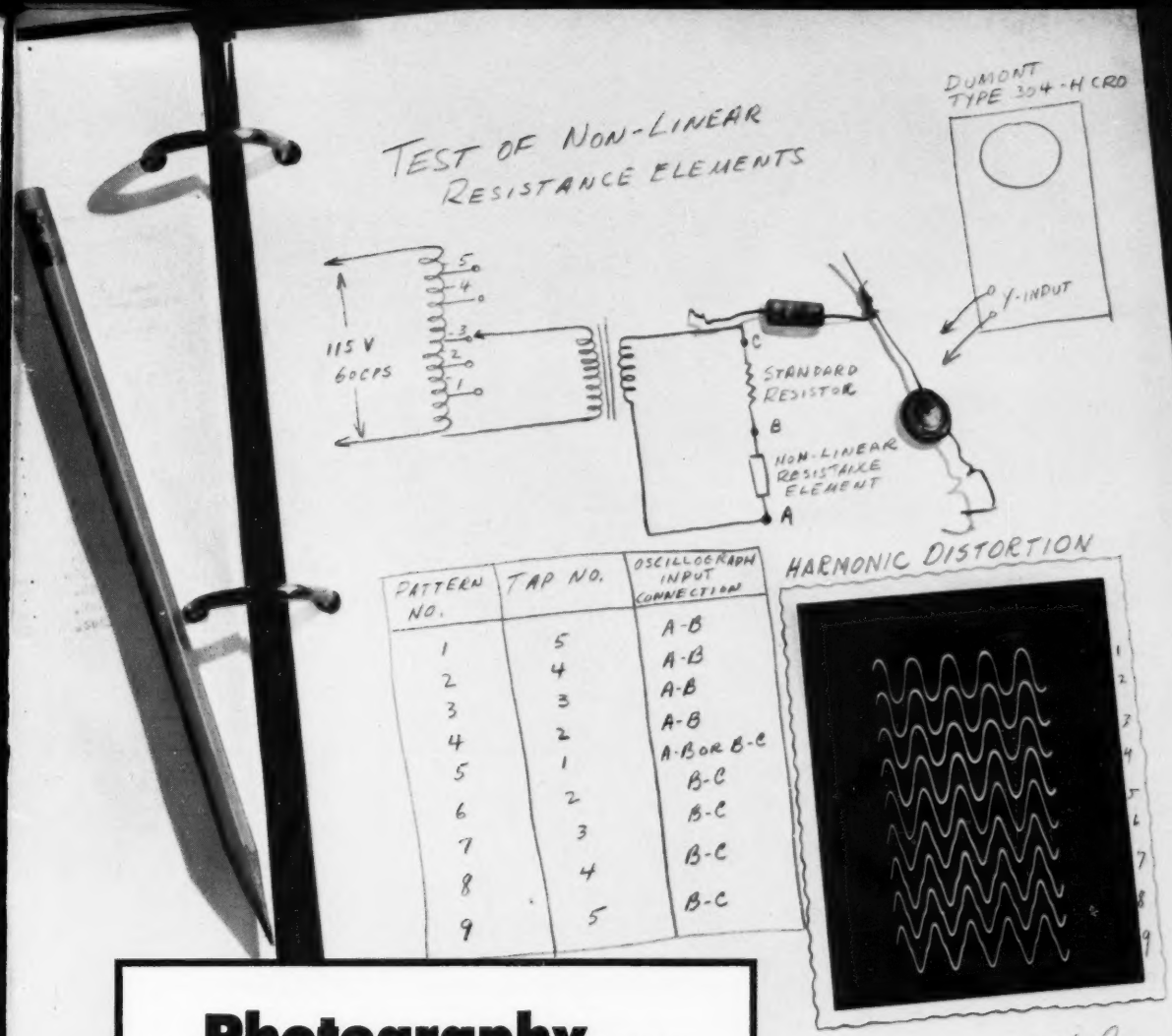
"I see that you need me," remarked the startled doctor.

"Yeah," agreed the student, "do you have a match?"

". . . insert in wastebasket 'Z'."

Some girls complained to the dean of women that the boys in the fraternity house next door never closed their blinds and that it embarrassed the girls.

They sent a note to the fraternity. "Dear Sirs," it read, "may we suggest you close your blinds, as we do not care for a course in anatomy." The men of the house promptly sent back the following answer: "Dear Ladies: This course is not compulsory."



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MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"What qualities do I need for a successful career with a company like General Electric?"

...HARRY K. LEADER, Lafayette College, 1954

Two answers to this question, given at a student information meeting held in July, 1952, between G-E personnel and representative college students, are printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 221-6, General Electric Co., Schenectady, N. Y.

G. C. HOUSTON, *Manufacturing Services Division* . . . While this is a rather broad question, I am sure it is one of real importance to any young man starting out in industry and looking forward to a position of responsibility in any of our successful industrial enterprises.

The mere asking of this question indicates that the individual has a definite goal or objective. This is important since progress can be made only if we attempt to reach a well-defined objective—even though it may be modified to some extent in the light of later experience. In G.E. we are looking for young men who have not only determined their objective but who are ready to work for it—who accept responsibility and have ability to get things done—who work well with others—to be a part of the team.

This calls for other qualities essential to long range success. We look for the enthusiastic individual, one not easily discouraged, and who can inspire the confidence of his co-workers. We desire individuals who show imagination and good judgment—particularly the ability to look ahead and maintain perspective beyond the immediate situation. Finally, we cannot overlook the qualities of loyalty and dependability since these are important in steering the individual through periods of discouragement which occur in every career.

When you decide on your business affiliation, make sure you associate yourself with a company that is soundly managed, that has a good business future, and that is the kind of company you would like to be a part of for the long pull.

E. S. WILLIS, *Corporate Services Division* . . . A successful career with a company like General Electric is built on the same qualities that contribute to success in any endeavor. However, in G.E., there is additional opportunity to develop these qualities because of the wide variety of training sources and openings which are available.

Basic qualities needed for any successful career include an open mind, willingness to accept responsibility, persistence, adaptability, co-operativeness, and common sense intelligence. Others such as physical well-being, ability of expression, and sound inquisitiveness also go to make up a truly qualified individual.

Most important is the fact that General Electric offers a wealth of opportunity to develop special capabilities and talents. The broad selection of training courses, in any chosen field, gives you a chance to sharpen your basic training and abilities. By decentralizing operations into about 70 different businesses, there is opportunity to see—in comprehendable dimensions—the full operation of the business. It means, too, that senior managers and young employees are more closely associated—a real advantage for the young man on his way up.

Also, our business requires specialists as well as managers. Thus, there are equal chances for success for those who concentrate in particular fields such as research, design, accounting, and planning.

So set your cap for a goal. And capitalize on your native qualities, which fortunately are different with each of us.

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